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Geology Energy Mineral (GEM) Resource Evaluation of the Rock Creek GRA, Montana, including the Quigg West (075-155) Wilderness Study Area

Bureau of Land Management
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ANCHORAGE, ALASKA
JULY 1983

WGM INC.
MINING AND GEOLOGICAL CONSULTANTS

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EXECUTIVE SUMMARY

The Rock Creek GRA is located in Granite County, Montana 16 miles west of the town of Philipsburg. The GRA includes one Wilderness Study Area - Quigg West (075-155).

The area is within the Montana Overthrust Belt, a region in which the rocks have been thrust eastward over one another to form repeating stacks of units. The bedrock in the Rock Creek GRA consists of sedimentary rocks that have been intruded by much younger rocks which may be part of the same intrusive system present at Butte, Montana. The bedrock is capped by stream, lake and glacial sediments and locally by young volcanic rocks.

The Rock Creek GRA is in a highly mineralized region. The Philipsburg mining district is located just east of the area and the Blackpine copper-silver-tungsten mine is 10 miles to the northeast. Placer gold occurs in many of the streams in the area and there is one small inactive gold-silver lode mine. U.S. Geological Survey geochemical data shows a strong barium anomaly in one stream draining the Quigg West WSA. Barium is commonly associated with gold mineralization in the area. In addition, parts of the WSA are covered by older gravels similar to gold-bearing gravels present in the eastern part of the GRA. The geochemical data combined with the presence of older gravels indicate moderate potential for both lode and placer gold within the WSA.

The geologic environment in the Quigg West WSA, and interpretation of available geochemical data indicate a low favorability for uranium, geothermal resources and oil and gas.

SUMMARY OF GEM RESOURCES

LAND CLASSIFICATION OF THE ROCK CREEK GRA, MONTANA

			Quigg West (075-155)
1.	Locatable Resources		
	a.	Metallic Minerals	3C
	b.	Uranium and Thorium	2C
	c.	Non-Metallic Minerals	3C (barite)
2.	Leasable Resources		
	a.	Oil and Gas	2C
	b.	Low Temperature Geothermal	1A
		High Temperature Geothermal	1A
	c.	Sodium and Potassium	1C
	d.	Other	1C
3.	Saleable Resources		3C (gravel)/ 2C (other)

ROCK CREEK GRA, MONTANA

1.0 INTRODUCTION

The Bureau of Land Management has adopted a two-phase procedure for the integration of geological, energy and minerals (GEM) resources data into the suitable/non-suitable decision-making process for Wilderness Study Areas (WSAs). The objective of Phase I is the evaluation of existing data, both published and available unpublished data, for interpretation of the GEM resources potential of the WSAs. During Phase I, Wilderness Study Areas are grouped into areas based on geologic environment and mineral resources. These areas are referred to as Geology, Energy, Mineral Resource Areas (GRAs).

The delineation of the GRAs is based on three criteria: (1) a 1:250,000 scale map of each GRA shall be no greater than 8½ x 11 inches; (2) a GRA boundary will not cut across a Wilderness Study Area; and (3) the geologic environment and mineral occurrences. The data for each GRA is collected, compiled, and evaluated and a report prepared for each GRA. Each WSA in the GRA is then classified according to GEM resources favorability. The classification system and report format are specified by the BLM to maintain continuity between regions.

This report is prepared for the Bureau of Land Management under contract number YA-553-CT2-1039. The contract covers GEM Region 2; Northern Rocky Mountains (Fig. 1). The Region includes 50 BLM Wilderness Study areas

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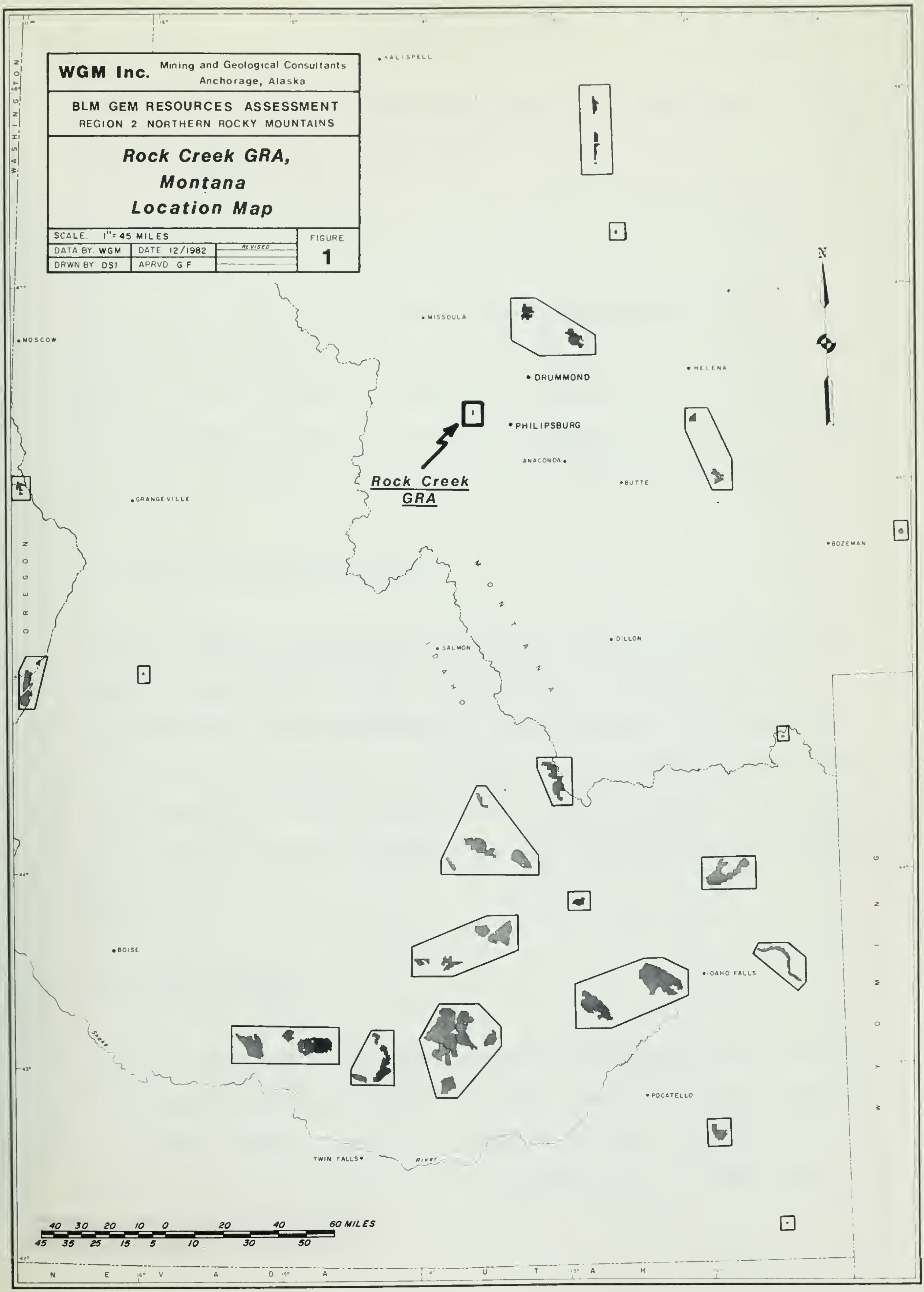
BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana Location Map

SCALE. 1"= 45 MILES		REVISED	FIGURE 1
DATA BY. WGM	DATE 12/1982		
DRWN BY DSI	APRVD G F		



totalling 583,182 acres. The WSAs were grouped into 22 GRAs for purposes of the Phase I GEM resources evaluation.

1.1 Location

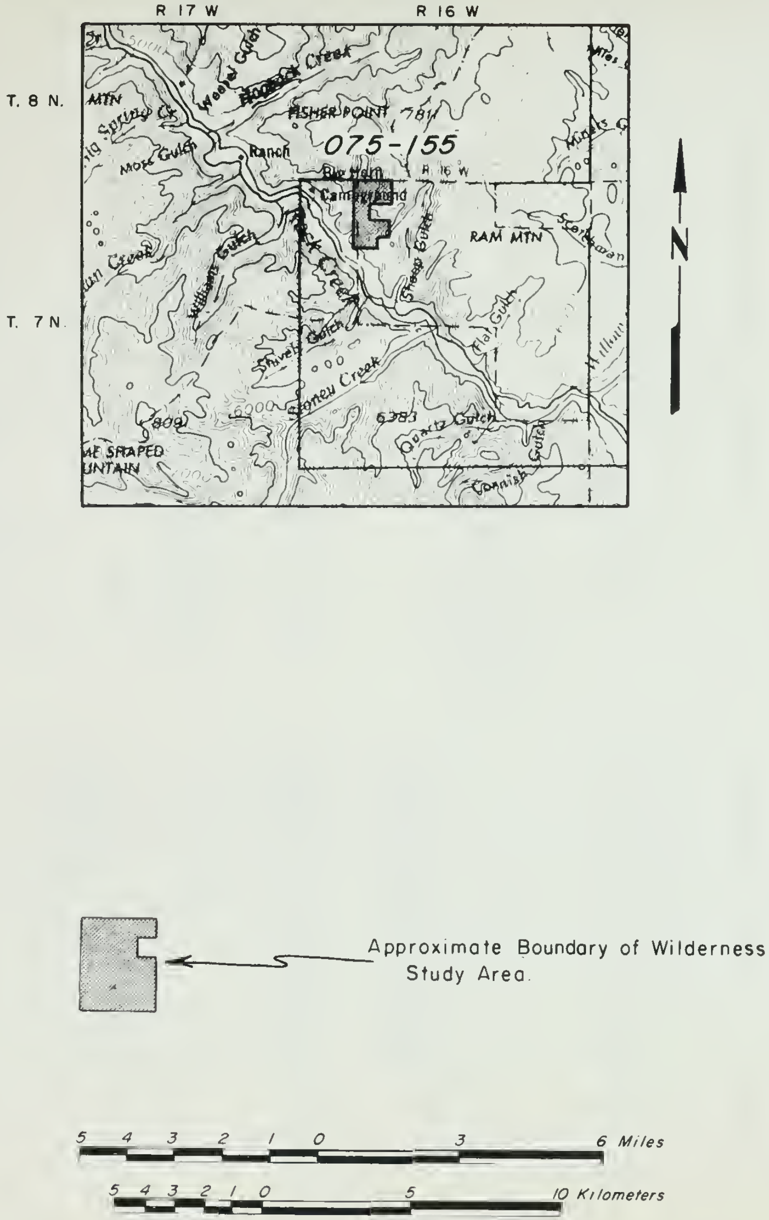
The Rock Creek GRA is located in Granite County, southwestern Montana at approximately 46°22'N, 113°37'W in Ts.7-8N. and Rs.16-17W. (Fig. 2). The GRA is 38 miles southeast of Missoula and 16 miles west of Philipsburg, in the Garnet Resource Area of the Butte BLM administrative district. The GRA includes one Wilderness Study Area - Quigg West (075-155) (Fig. 2).

1.2 Population and Infrastructure

There are numerous ranches and private homes along Rock Creek, which flows through the Rock Creek GRA, but no major towns are within the area. A maintained gravel road runs along Rock Creek from south of Clinton to west of Philipsburg and passes near the southern boundary of WSA 075-155. There are four-wheel drive roads up many of the valleys in the GRA. The nearest paved road is a portion of the Rock Creek Road seven miles east of the Quigg West WSA.

1.3 Basis of Report

This report is based on a compilation, review, and analysis of the available published and unpublished data on the geology, energy and mineral resources of the Rock Creek GRA. The GRA is located in the Butte NTMS quadrangle which is currently the subject of a U.S. Geological Survey CUSMAP study and



BLM Wilderness Study Areas Included in the Rock Creek GRA.

WSA	NAME	ACREAGE
075-155	Quig West	520

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana

Topographic Map

SCALE 1"=4 MILES (1 250,000)			FIGURE
DATA BY WGM	DATE 9/1982	REVISED	2
DRWN BY DSI	APRVD G.F.		

was previously covered by a Department of Energy NURE study. Consequently, a considerable amount of geologic and geochemical data are available. BLM records of mining claims and oil and gas leases in the area were compiled and records of oil and gas well data at the Montana Oil and Gas Conservation Board were searched. Areal photographs, loaned to WGM by the BLM Missoula office and LANDSAT IMAGES located by the BLM in Billings were examined. Additional information was gained from U.S. Geological Survey geologists at the CUSMAP conference held in Butte in June 1982. In October 1982 WGM geologists visited the Black Pine Mine and some gold placer claims several miles east of the Quigg West WSA. The data was compiled and reviewed by WGM project personnel and the panel of experts to produce the resource evaluation which comprises this report. Personnel associated with this evaluation are:

Greg Fernette, Senior Geologist, WGM Inc.	Project Manager
C.G. Bigelow, President, WGM Inc.	Chairman, Panel of Experts
Joel Stratman, Geologist, WGM Inc.	Project Geologist
Jami Fernette, Land and Environmental Coordinator, WGM Inc.	Claims and Lease Compilation

Panel of Experts

C.G. Bigelow, President, WGM Inc.	Regional geology, metallic and minerals, mineral economics.
R.S. Fredericksen, Senior Geologist, WGM Inc.	Regional geology, metallic minerals.
David Blackwell, Ph.D., Professor of Geophysics, Southern Methodist University	Geothermal.
Jason Bressler, Senior Geologist, WGM Inc.	Regional geology, metallic minerals.
Gary Webster, Ph.D., Chairman, Department of Geology, Washington State University	Oil and gas.

William Jones, Senior Geologist, WGM Inc.	Metallic minerals, coal, industrial minerals.
J.F. McOuat, President, Watts, Griffis & McOuat Ltd.	Mineral economics, and industrial minerals.
E.F. Evoy, Senior Geologist, Watts, Griffis & McOuat Ltd.	Uranium and thorium.

1.4 Acknowledgements

We would like to acknowledge the assistance of a number of individuals who aided in the completion of this report. Dave Williams, BLM-Butte district geologist, contributed useful discussion on the regional geology, and loaned WGM data on claims and mineral occurrences. Jerry Klem, BLM-Billings aided in the land review, the search of oil and gas well records and loaned LANSTAT photos. Dr. Syd Groff, Don Lawson, Henry McClernan and Richard Berg of the Montana Bureau of Mines and Geology gave freely of their knowledge of the area.

Alan Silva, mine geologist at the Black Pine Mine, guided WGM geologists on a tour of the mine. Mr. Everett Miller of Philipsburg allowed WGM to visit his claims and sample the gold bearing gravels. Wes Campbell, U.S. Geological Survey, provided a pre-publication copy of the geochemical data on the Rock Creek GRA.

In particular, we would like to thank Mindy Mason, BLM Missoula, for assistance in the compilation phase of the project.

2.0 GEOLOGY

2.1 Introduction

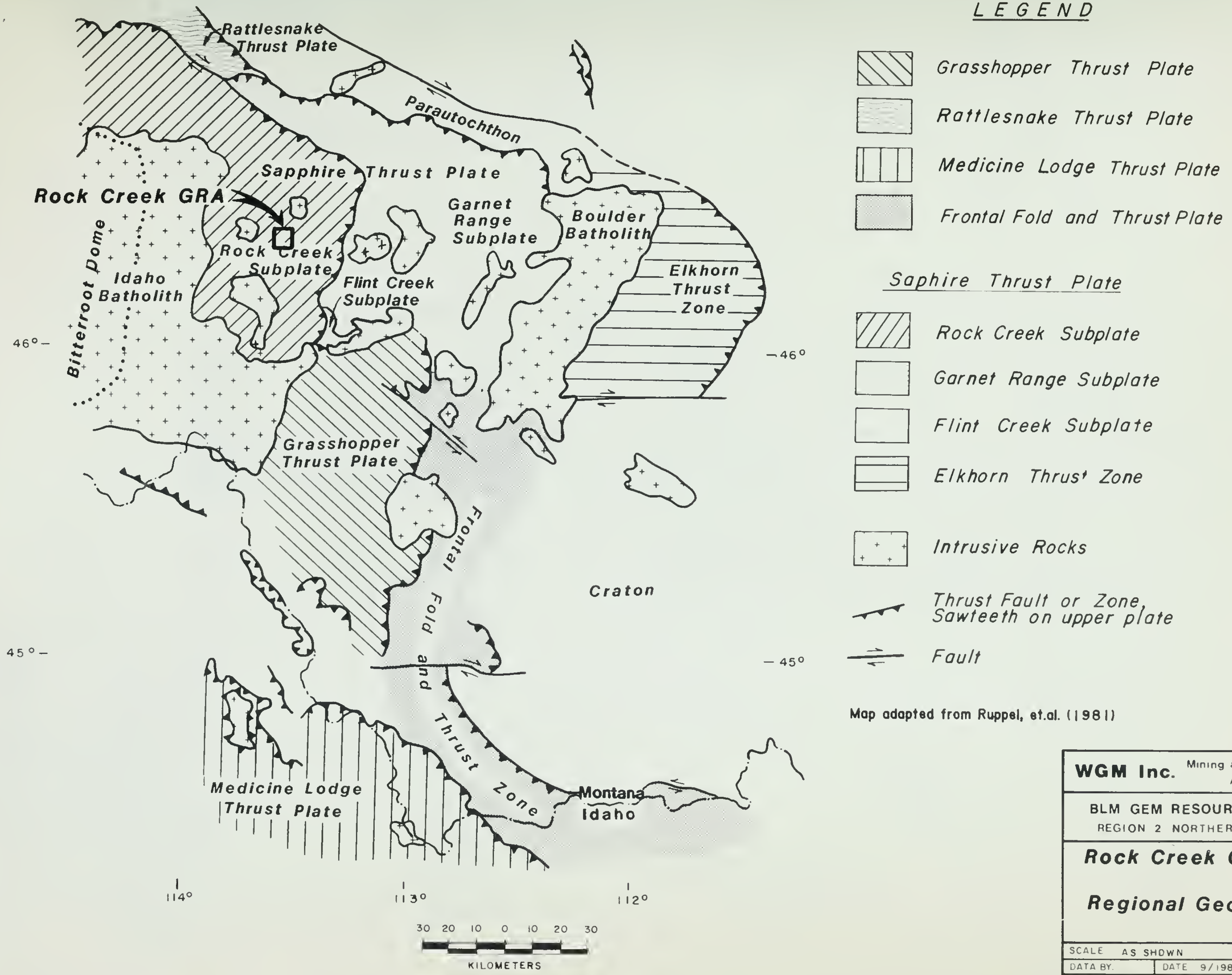
The Rock Creek GRA is within the Rocky Mountains Thrust Belt (Fig. 3). The GRA is underlain by Precambrian (over 600 m.y.), Paleozoic (600-230 m.y.), and Mesozoic (230-65 m.y.) sedimentary rocks (Fig. 4), all of which are intruded by Late Cretaceous (100-65 m.y.) and Tertiary (65-2 m.y.) granitic stocks (Ruppel et al., 1981; Wallace et al. 1981).

2.2 Physiography

The Rock Creek GRA is in the northern Rocky Mountains physiographic province (Alden, 1953; Hunt, 1974). The major topographic feature in the GRA is Rock Creek valley which bisects the area from northwest to southeast. The valley is flanked by north- to northwest-trending ridges and U-shaped stream valleys. The highest elevation in the GRA is 7,811 feet at Fisher Point. Local relief is in the range of 1,000 to 3,200 feet. The topography is steep and locally rugged. Bedrock exposures tend to be mantled by alluvium, lake sediments and glacial till.

2.3 Lithology and Stratigraphy

The Rock Creek GRA is underlain primarily by layered rocks of the Belt Supergroup (Fig. 5). These rocks were deposited in the Belt Basin during Precambrian Y (1600-800 m.y.) time (Harrison, 1972).



Map adapted from Ruppel, et.al. (1981)

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REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana

Regional Geologic Setting

SCALE AS SHOWN			FIGURE
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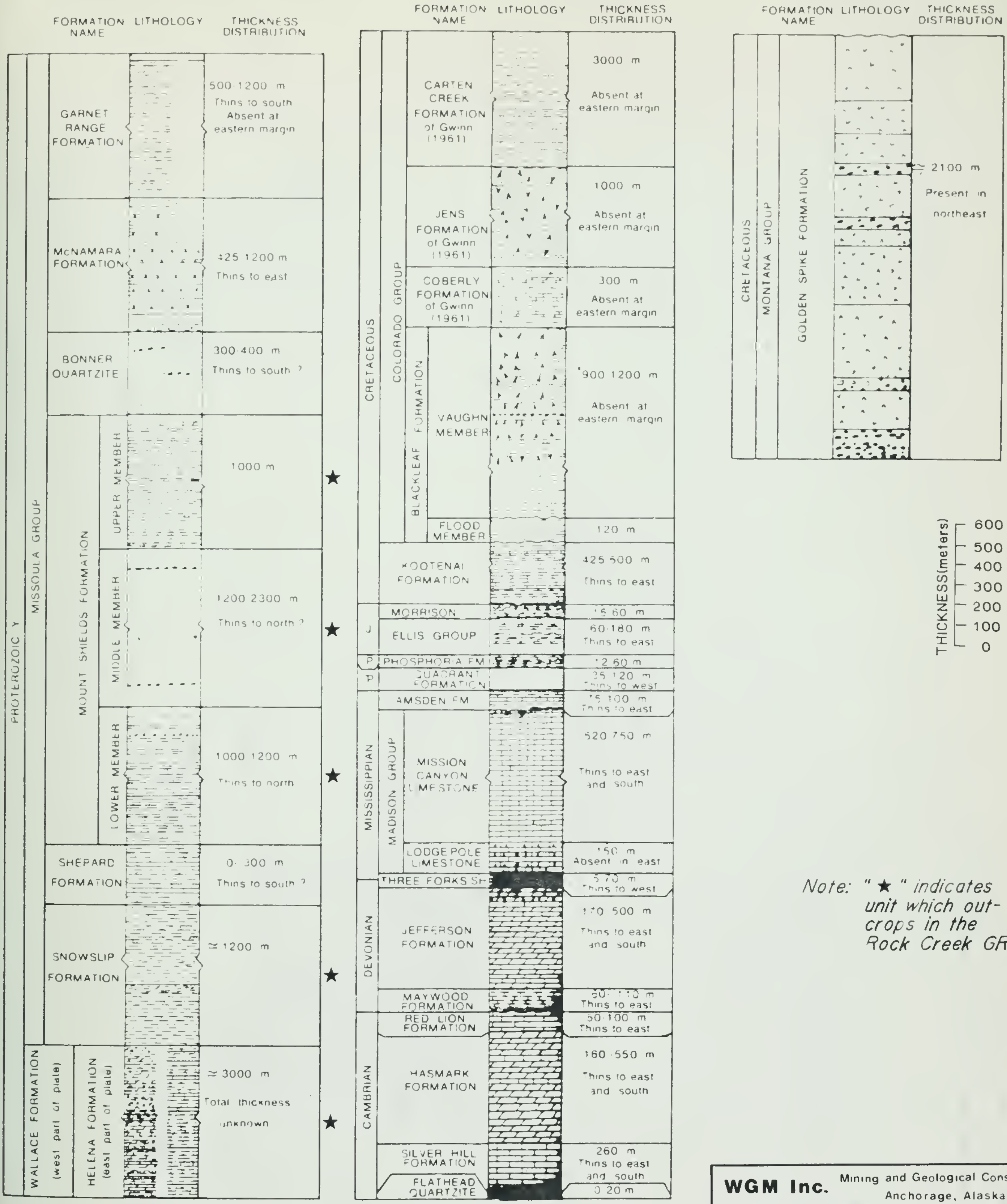
DRWN BY DSI	APRVD G.F		



Note: " ★ " indicates unit which outcrops in the Rock Creek GRA.

Data by: Rupple, et.al., (1981).

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REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana
Stratigraphic Column
of the
Saphire Thrust Plate

SCALE AS SHOWN			FIGURE
DATA BY	DATE 9/1982	REVISED	4
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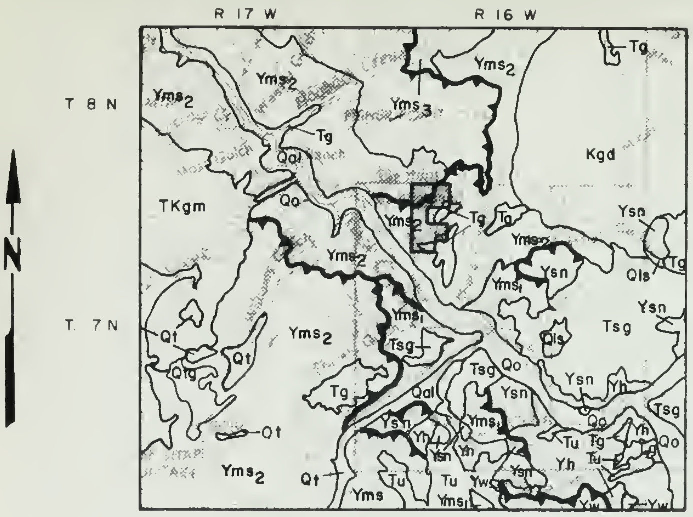

EXPLANATION

Sedimentary

Qal Alluvium

Qo Outwash deposits

Tsg Lake deposits and volcanic ash

Qls Landslide deposits

Tg Alluvial gravel

Qt Glacial Till

Mount Shields Farmation

Yms	3	Yms_3	Unit 3
	2	Yms_2	Unit 2
	1	Yms_1	Unit 1

Ysn Snowslip Formation

Yw Wallace Formation

Yh Helena Farmatian

Igneous

Qtg Alluvial gravel and fan gravel

TKgm Quartz monzonite plutons

Tu Lava tuff breccia

Kgd Granodiorite stacks and dikes

Pleistocene

Tertiary

Cretaceous

Precambrian Y

Data by: Wallace, et. al, 1981

Contact

Thrust Fault, teeth on upper plate.

▨ Approximate Boundary of Wilderness Study Area.

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana

Geologic Map

SCALE: 1"= 4 MILES (1:250,000)			FIGURE
DATA BY.	DATE. 9/1982	REVISED	5
DRWN BY DSI	APRVD G.F.		

The oldest unit in the Rock Creek GRA is the Wallace Formation. The base of the Wallace Formation is not exposed in the GRA. The unit is at least 4,000 feet thick (Hughes, 1970 and 1975) and is exposed in the west part of the Sapphire thrust plate (Ruppel et al., 1981). The formation consists mainly of a thick sequence of calcareous argillite and siltite with minor amounts of sandy material (Hughes, 1970). The lithologies can be subdivided into three parts (Ruppel et al., 1981): (1) a lower thin bedded dolomitic siltite, dolomitic quartzite, black argillite, argillaceous dolomite and minor limestone, (2) a thick sedimentary breccia composed of fragments derived from the lower unit by mass movement to the east (Wallace et al., 1976), and (3) a thinly laminated interbedded green argillite and siltite with minor dolomite and siltite with minor dolomite and limestone. The Wallace Formation was deposited on an eastward sloping shelf (Wallace et al., 1976) from a source area to the west or southwest (Ruppel et al., 1981).

The Helena Dolomite is over 10,000 feet thick and consists of of a sequence of limey siltite, limey argillite, and argillaceous limestone with lesser interbedded dolomite (Ruppel et al., 1981). Further to the east and north it is composed mainly of carbonate rocks (Harrison, 1972). Regionally the Helena is known as the middle belt carbonate and represents the shoreward equivalent of the predominantly clastic Wallace Formation (Mudge and Earhart, 1978). In the Rock Creek area the Helena Formation is present in the eastern part of the Sapphire thrust plate and it contains fewer dolomite beds than it does elsewhere. The coeval Wallace Formation contains less coarse detritus and is less calcitic than the Helena in the Rock Creek area. This suggests that the Helena-Wallace Formations in the Rock Creek area were deposited near the axis of the Belt Basin (Ruppel et al., 1981).

The Wallace and Helena Formations are overlain by rocks belonging to the Missoula Group. The contact between these two assemblages is defined as the horizon where hematitic feldspathic red and green clastics characterized by chlorite on bedding planes overlie carbonate or green to black slightly carbonatic pelitic strata of the middle Belt carbonate. This contact is one of the sharpest in the entire Belt Supergroup (Harrison, 1972). The Missoula Group consists of the Snowslip Formation (oldest), the Shepard Formation, the Mt. Shields Formation, the Bonner Quartzite, the McNamara Formation, and the Garnet Range Formation in the Rock Creek region.

The lowermost unit in the Missoula Group, the Snowslip Formation, is a 4,000 foot thick sequence of predominantly red argillaceous rocks (Ruppel et al., 1981). Minor interbeds of green argillite, siltite and coarse white quartzite interbeds are also present. The predominance of red hematitic clastics in the Missoula Group indicates deep lateritic weathering in the source area. The deep weathering could have resulted from uplift of the source terrane along with renewed subsidence of the basin (Harrison, 1972). The location of the source area for the Snowslip is unclear but was at least in part to the west (Ruppel et al., 1981).

The overlying Shepard Formation is not present in the Rock Creek GRA due to southward thinning. To the north, the Shepard is up to 915 feet thick. The Shepard is green thinly laminated argillite and siltite that contains common limestone and dolomitic siltite beds (Ruppel et al., 1981).

The youngest Precambrian unit in the Rock Creek GRA is the Mt. Shields Formation which also underlies the Quigg West WSA (Fig. 5). It is comprised

of three members, designated Unit 1, 2, and 3 (Wallace et al., 1981). The basal Unit 1, 3,300 to 4,000 feet thick, is predominantly thick bedded feldspathic quartzite. Unit 2, 5,000 to 7,500 feet thick, is composed of thick bedded, coarse-grained, feldspathic quartzite with some conglomerate interbeds. The uppermost Unit 3, about 3,300 feet thick, consists of interbedded red argillite, siltite and fine grained quartzite. The Mt. Shields Formation comprises a deltaic sequence and the increase in thickness of the middle unit to the south and southwest indicates a source area to the southwest (Ruppel et al., 1981).

Although younger Precambrian, Paleozoic and Mesozoic sedimentary rocks are present nearby, none are exposed within the Rock Creek GRA.

A variety of Cenozoic (65 m.y.-present) volcanic and sedimentary units are present in the Rock Creek GRA, but the only descriptions of these units are from areas east and south of the GRA (Emmons and Calkins, 1913). Tertiary (65-2 m.y.) deposits present in the GRA include lava, lake deposits, volcanic ash, and terrace gravels. Pink andesite porphyry with some flow breccia and tuff crops out low in Rock Creek valley. These lavas erupted in Miocene(?) time (23-6 m.y.) into an ancient valley (Emmons and Calkins, 1913). Miocene deposits composed of soft, nearly massive buff colored volcanic ash interbedded with lake sediments mantles hillsides in the eastern part of the GRA. Scattered exposures of older gravels, deposited as ancient stream terraces, cap several ridges in the area (Emmons and Calkins, 1913) including part of the Quigg West WSA (Wallace et al., 1981).

Pleistocene (2-0.1 m.y.) deposits in the Rock Creek GRA include glacial till, outwash, landslide debris, and alluvium (Wallace et al., 1981). The glacial deposits were deposited by glaciers which probably originated in the Flint Creek Range to the east (Emmons and Calkins, 1913).

The Belt Supergroup is intruded by Late Cretaceous granitic plutonic rocks which have been described in detail by Hughes (1971, 1975). One of these plutons, the Miners Gulch stock, underlies the northeast part of the Rock Creek GRA (Fig. 5). It consists of an outer margin of medium-grained quartz-diorite that grades inward to a granodiorite core (Hughes, 1971). Smaller stocks of Cretaceous (141-65 m.y) or Tertiary age also occur in the area, but they are too small to show on Figure 5. These stocks are composed of quartz monzonite porphyry and show evidence of multiple intrusion (Hughes, 1971 and 1975). Hughes (1971) concludes that these smaller intrusives, at least in the GRA, are comagmatic with the Miners Gulch Stock.

The southwestern part of the GRA is underlain by quartz monzonite of Cretaceous or Tertiary age (Wallace et al., 1981). There are no published descriptions of these intrusive rocks.

2.4 Structural Geology and Tectonics

The tectonic setting of the Rock Creek GRA is complex. Regionally the area lies within the Sapphire thrust plate (a part of the Montana Thrust Belt) situated between the Bitterroot Dome of the Idaho Batholith to the east and the Boulder Batholith to the west (Fig. 3). The Sapphire thrust plate is clearly a tectonic unit due to the distinguishing physical characteristics

and patterns of distribution of the thrust faults and folds within it. These characteristics and patterns include: (1) anastomosing imbricate thrust faults, the spacing of which is closely related to the types of rocks involved in faulting; (2) abundant younger-over-older thrusts, mixed steep and flat west-dipping thrusts and some east-dipping thrusts; (3) isoclinal folds that are overturned towards the east; and (4) the non-coherent breccia of sole zones of thrust faults (Ruppel et al., 1981). The Sapphire thrust plate can be further divided into three structural divisions; the Rock Creek, the Garnet Range, and the Flint Creek subplates.

The Sapphire tectonic block consists of carbonates and clastics belonging to the Belt Supergroup, carbonate and minor clastic rocks of Paleozoic age, and an abnormal sequence of Mesozoic clastic rocks. The block appears to have formed the roof and upper part of the eastern half of the Idaho Batholith at the time of magma emplacement. Thus, the lower part of the block probably consists of granite detached from the roof of the batholith. Small granitic plutons commonly penetrate the Sapphire block and its crumpled fringe. Eastward movement of the thrust plate appears to be about 40 miles as indicated by: (1) the distance between the apparent center of the Sapphire block and that of the Bitterroot Dome and (2) the minimum values for movement based on rotation of earlier folds by simple shear in the detachment zone and for movement on thrust faults in the leading edge of the block is 10 and 15 miles, respectively (Hyndman, 1978).

The Rock Creek GRA is within the Rock Creek subplate of the Sapphire thrust plate (Fig. 3). This subplate is confined to the northeast part of the Bitterroot Mountains and to the Sapphire and John Long Mountains. Its

frontal edge may extend into the west part of the Flint Creek Range and into the Anaconda Range. The structure of the subplate is characterized by: (1) imbricate, anastomosing, listric thrust faults that dip to the west; (2) flat thrusts interspersed with steeply dipping thrust faults and reverse faults; (3) broad, open, gently plunging folds; and (4) younger-over-older thrust faults that occur in association with older-over-younger thrust faults (Ruppel et al., 1981). Pre- and post-intrusion normal faults with associated parallel tension fractures and bedding-plane faults are also common in the area (Hughes, 1971 and 1975).

A group of stocks known as the Henderson-Willow Creek igneous belt (Hughes, 1970) has intruded the folded and faulted metasedimentary rocks (Hughes, 1971). These plutons could be outliers to the Boulder Batholith or related to the eastern salient of the Idaho Batholith (Hyndman et al., 1982). The Miners Gulch stock which outcrops in the northeast part of the Rock Creek GRA belongs to this belt. These stocks have sharp, discondant contacts which show chill effects. The internal structure and zoning of many of the stocks suggest eastward lateral flowing during emplacement (Hughes, 1975). The smaller granitic plutons in the Sapphire block apparently lie along essentially contemporaneous westward-dipping thrust faults (Hyndman, 1978).

Many of the mineral deposits in the region are spatially and genetically related to the intrusive rocks (J.E. Elliot, Oral Comm., 1982). Moreover, fracture-vein-type mineralization is common in the area (Emmons and Calkins, 1913) and may be controlled by the various normal fault sets.

2.5 Paleontology

No fossils are reported in the Belt rocks in the Rock Creek GRA. Tertiary vertebrate and plant fossils are found in Cenozoic rocks near Drummond approximately 30 miles northeast (Fig. 1).

2.6 Geologic History

The Precambrian Belt Basin in which the sedimentary rocks underlying the Rock Creek GRA were deposited developed about 1450 m.y. ago. It was an active depositional basin for 600 m.y. (Harrison, 1972) forming a major northwest-trending trough which was the site of deltaic, shelf and basin sedimentation. This is shown by the Wallace and Helena Formations which comprise a shelf-slope sequence and a basin-axis facies with the source and shelf located to the west (Ruppel, et al., 1981). Rocks belonging to the Mt. Shields Formation, a thick northeasterly prograding delta sequence, indicate a period of renewed subsidence and deposition (Ruppel et al., 1981). The remainder of the belt sequence and any overlying Paleozoic or Mesozoic rocks which were deposited in the GRA were removed by erosion, probably during Late Cretaceous time.

Radiometric and stratigraphic evidence indicate that the Sapphire thrust plate was emplaced during Late Cretaceous time. Granodiorite belonging to the Garnet Pluton (in the western Garnet Range) which cuts thrust faults of the leading edge of the Sapphire block, yields radiometric ages of 82.4 ± 1.0 m.y. from hornblende and 79.1 ± 7 m.y. from biotite. The age of the hornblende represents a minimum age; therefore, thrust faulting appears to

have ceased before 82 m.y. (Ruppel et al., 1981). The Sapphire thrust plate cut a large segment of the Idaho Batholith, which was probably in its latest stages of crystallization at the time since almost undeformed potash-feldspar megacrysts cut across the shears of the detachment zone. A few potassium-argon and fission-track dates from the border zones indicate that the batholith was emplaced about 70 to 90 m.y. ago.

The origin of the smaller granitic bodies is not fully understood, but they appear to lie along essentially contemporaneous westward dipping faults (Hyndman et al., 1975). If the magmas were emplaced into the Sapphire block prior to or during movement of the block, their source would have probably been in the Idaho Batholith magama-generation zone. However, most of the plutons have injected pre-existing thrust faults and are undeformed. Thus, the smaller plutons evidently intruded to their present level after the Sapphire block had ceased movement, and after solidification of much of the Idaho Batholith (Hyndman, 1978).

In Tertiary time the area was the site of volcanic activity and was partially covered by lakes (Emmons and Calkins, 1913). The most recent events in the geologic history were the Pleistocene glaciations to the east of the Rock Creek GRA which resulted in deposition of outwash, fill, and alluvium.

3.0 MINERAL AND ENERGY RESOURCES

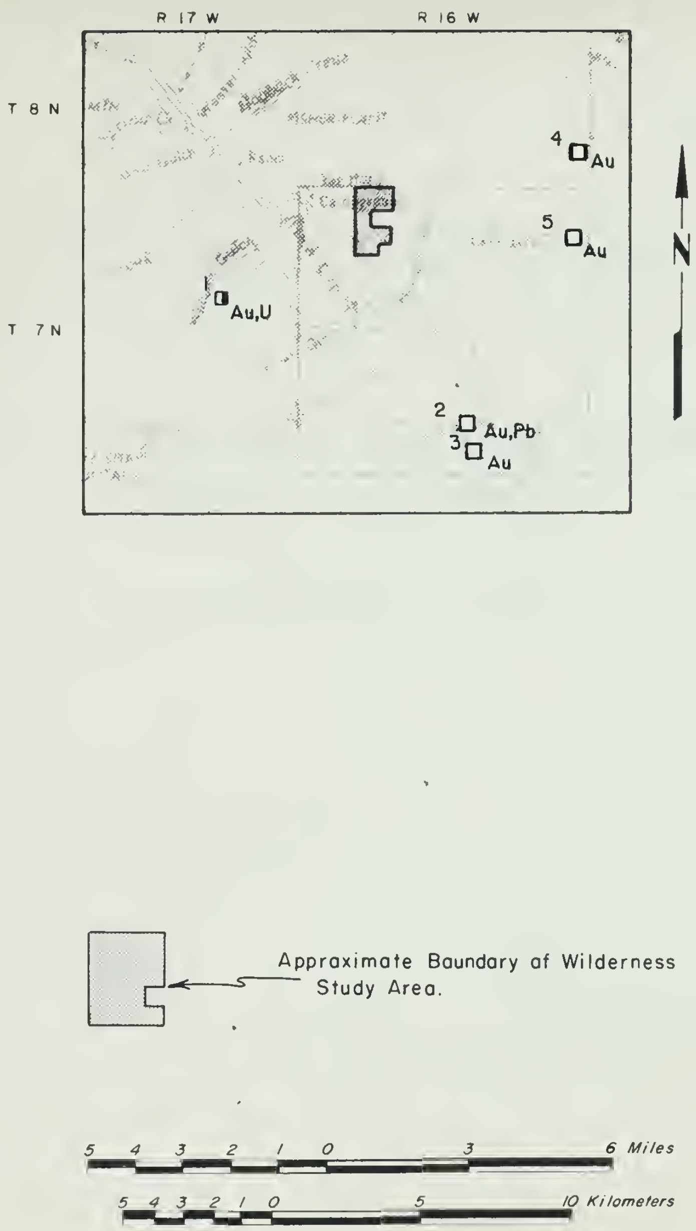
3.1 Known Mineral and Energy Deposits

There are presently no producing mines within the Rock Creek GRA although several companies and individuals are actively exploring the area, particularly for placer gold. The Bagdad mine, located three miles southwest of the Quigg West WSA, produced a small amount of gold in the early 1900s (Stout and Ackerman, 1958) but exact production figures are not available (loc. 1, Fig. 6; Table I). Development of three adits totalling 800 feet was completed in the early 1900s. The mineralization consists of gold and silver with small amounts of chalcopyrite, galena, sphalerite and molybdenite in quartz veins. The veins trend east-west and dip steeply to the south. The host rocks are tan quartzites belonging to Unit 3 (or the upper member) of the Mt. Shields Formation (Wallace et al., 1981). There is no data on grade or reserves of the deposit. Steeply dipping vein deposits of this type are common in the Philipsburg district (Prinz, 1967) and in the area east of the GRA (Emmons and Calkins, 1913).

There are no reported energy deposits in the Rock Creek GRA.

3.2 Known Mineral and Energy Prospects, Occurrences and Mineralized Areas

There are four reported mineral prospects/occurrences, all of which are placer gold, in the Rock Creek GRA (loc. 2-6, Fig. 6; Table I). There has been past mining activity at Big Springs Creek, Quartz Creek and Basin Creek


R 17 W
R 16 W
T 8 N
T 7 N
N
1 Au,U
2 Au,Pb
3 Au
4 Au
5 Au
Appraximate Baundary af Wilderness Study Area.
5 4 3 2 1 0 3 6 Miles
5 4 3 2 1 0 5 10 Kilometers

LEGEND

- ■ *Mineral Orebody*
- ◧ *Mineral Deposit*
- ☐ *Minerai Occurrence*
- ⚒ *Active Quarry*
- ✕ *Inactive Quarry*
- ✕ *Active gravel or clay pit*
- ✕ *Inactive gravel or clay pit*

1 ☐ Cu
1 — *occurence number*
Cu — *commodity*

Au - *Gold*
Cu - *Copper*
U - *Uranium*
Ab - *Abrasives (Corundum)*

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Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana

Mineral Deposits and Occurrences

SCALE. 1" = 4 MILES. (1.250,000)			FIGURE
DATA BY: WGM	DATE 9/1982	REVISED	6
DRWN BY DSI	APRVD G.F		

TABLE I

MINERAL OCCURRENCES OF THE ROCK CREEK GRA, MONTANA

Map No.	Name	Location Sec.	T.	R.	Commodity	Type of Occurrence	Description	Source of Data
1	Bagdad Mine	14	7N	17W	Au, Ag, U	Adits	Gold and sulfide bearing quartz veins in quartzite. Anomalous radioactivity reported but no uranium minerals. Small amount of gold produced in early 1900s.	Stout and Ackerman (1958, 1959), Salisbury and Dietz (1982).
2	Quartz Creek	27	7N	16W	Au, Corundum	Placer	Small placer.	Lyden (1948), MILS.
3	Basin Creek	34	7N	16W	Au	Placer	Small placer.	Lyden (1948), MILS.
4	Miners Gulch	36	8N	16W	Au	Placer	Placer in Tertiary(?) gravels.	Everett Miller, pers. comm. (1982).
5	Scotchman Gulch	12	7N	16W	Au	Placer	Placer in Tertiary(?) gravels.	Everett Miller, pers. comm. (1982).

but the amount of production is not recorded (Lyden, 1948). In addition, there is evidence of past placer activity (circa 1900) in the Scotchman-Miners Gulch area on upper Willow Creek. Several hundred cubic yards of gravel were mined during the summer of 1982 in Scotchman's Gulch (Everett Miller, pers. comm., 1982). The Big Springs, Miners Gulch and Scotchman Gulch placers are underlain by intrusive rocks, a relationship which is common throughout the Butte quadrangle (J.E. Elliot, pers. comm., 1982). The Quartz Creek and Basin Creek placers are underlain by thrust faulted Mt. Shields Formation and undisturbed Tertiary lava. It is possible that there are subsurface extensions of intrusive rocks into this area (Hughes, 1975). According to the U.S. Bureau of Mines MILS file entry for the Quartz Creek placer, corundum as well as gold is present. This could indicate contact metamorphism in the area.

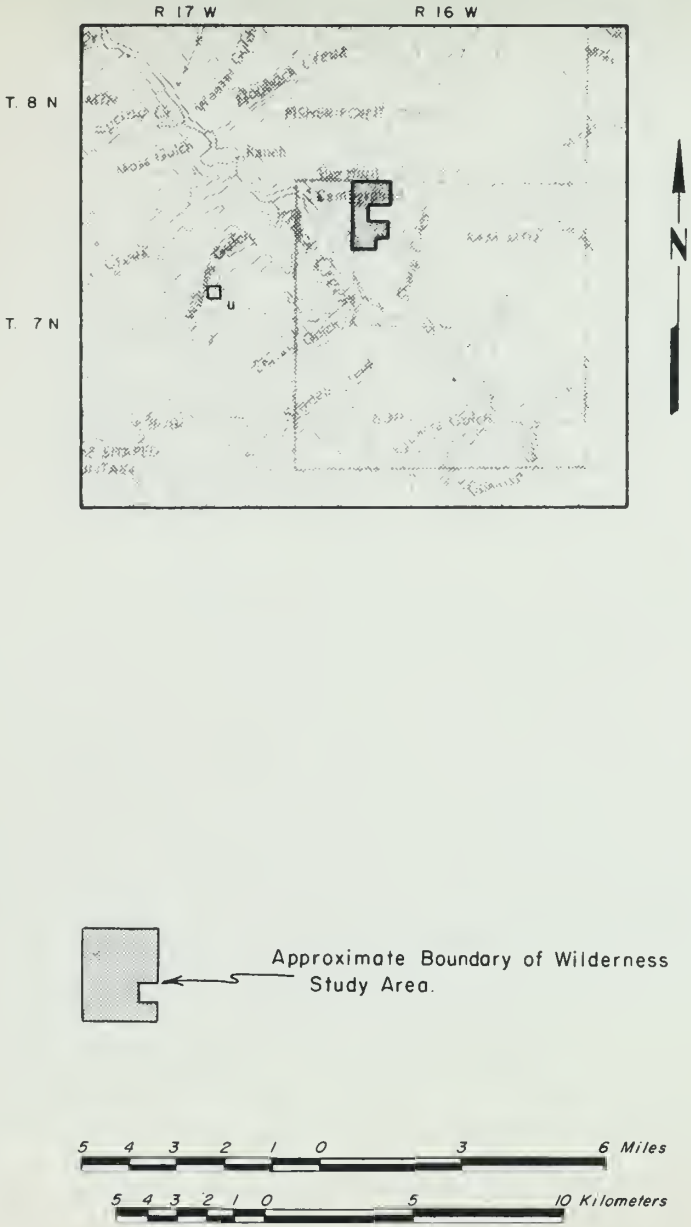
It is probable that placer gold occurs in most of the drainages in the northeast part of the Rock Creek GRA. Everett Miller, who holds the claims on Miners Gulch, states that gold occurs in the lower parts of all of the streams draining the Miners Gulch stock. WGM geologists visited the placers on Scotchman and Miners Gulches in October 1982 (Appendix I). Gold was recovered from panned samples at every location visited. Much of the gold is very fine-grained. Coarser grains often have well developed crystal faces indicating either a short transport distance or in-situ crystallization during stream transport. The gold occurs in the valleys and in older gravels which cap the ridges. These gravels are mapped as Tertiary by Wallace et al. (1981). Similar Tertiary gravels cap the ridge in the southeastern part of the Quigg West WSA (Fig. 5).

Quartz-barite-pyrite veins up to several tens of feet in width are common in the granodiorite underlying the Miners and Scotchman Gulch area (James Miller, pers. comm., 1982). These veins may be the source of the gold in the placers. No published descriptions of these veins are available.

The Bagdad mine has been classed as a uranium occurrence by Salisbury and Dietz (1982) and is the only known energy resource occurrence in the Rock Creek GRA (Fig. 7). Anomalous radioactivity, up to 12 times background, associated with a quartz vein in one of the adits is reported by an Atomic Energy Commission examiner. Salisbury and Dietz (1982) report that no uranium minerals occur at the mine and that radioactivity up to 2.5 times background occurs on one of the mine dumps. Two selected samples of pyritic quartzite contained 4 and 8 ppm U_3O_8 (Salisbury and Dietz, 1982). There are no reported geothermal, oil and gas, or coal occurrences in the Rock Creek GRA.

3.3 Mining Claims, Leases and Material Sites

A review of BLM claims records current to August 30, 1982 shows that there are 130 unpatented mining claims in Ts.7 and 8N., Rs.16 and 17W. (Fig. 8) and six patented mining claims in T.7N., R.16W. There are no mining claims in the Quigg West WSA. The majority of the unpatented claims are on Quartz Creek. Except for four unpatented claims northwest of the WSA, all of the claims surround mineral occurrences discussed previously.


R 17 W
R 16 W
T. 8 N
T. 7 N
U
N
Approximate Boundary of Wilderness Study Area.
5 4 3 2 1 0 3 6 Miles
5 4 3 2 1 0 5 10 Kilometers

LEGEND

- ● oil well
- ✷ oil and gas well
- ☼ gas well
- ☼ well with show of gas
- ● well with show of oil
- ✷ well with show of oil and gas
- ○ shut in well
- ⌖ dry hole—abandoned
- ○ tight hole or well in progress as of July, 1982
- ◌ O Oil field
- ◌ G Gas field
- ◌ OS Oil shale
- ◆ O Oil show or seep
- ⬢ C Coal deposit
- ⬡ C Coal occurence
- ● Gt Thermal water
- ◌ Gt Geothermal area
- ☐ U Uranium occurence / deposit
- ☐ Th Thorium occurence / deposit

X Hydrocarbon Source Rock Sample

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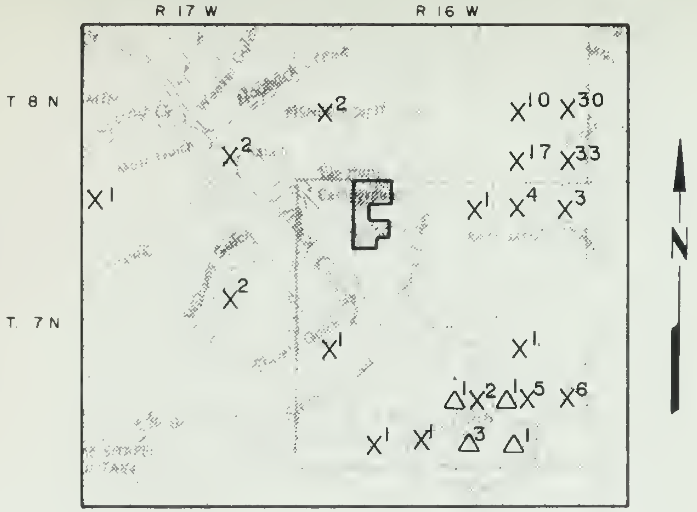
BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana
Energy Resource Occurrence Map

SCALE: 1" = 4 MILES (1:250,000)
DATA BY: WGM DATE 9/1982 REVISED
DRWN BY DST APRVD G.F

FIGURE
7



EXPLANATION

X Unpatented Mining Claim

△ Patented Mining Claim

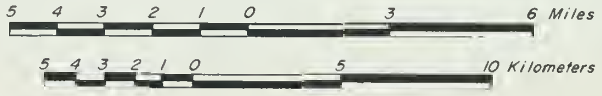
NOTES: 1) Number adjacent to symbol indicates number of mining claims in that section.

2) Area of claims search: GRA

3) Data current to: August 30, 1982

4) Source of Data: BLM Claims Microfiche.

▨ Approximate Boundary of Wilderness Study Area.



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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana

Mining Claims
Density Map

SCALE: 1" = 4 MILES (1:250,000)
DATA BY: WGM DATE 9/1982 REVISED
DRWN BY DSI APRVD GF
FIGURE 8

Oil and gas lease plats for T.7N., Rs.16 and 17W., including the Quigg West WSA, were reviewed (Fig. 9). Most of the two townships are covered by lease applications. Two lease applications, filed in May 1981, cover the Quigg West WSA (Table II). The above records are current to August 4, 1982.

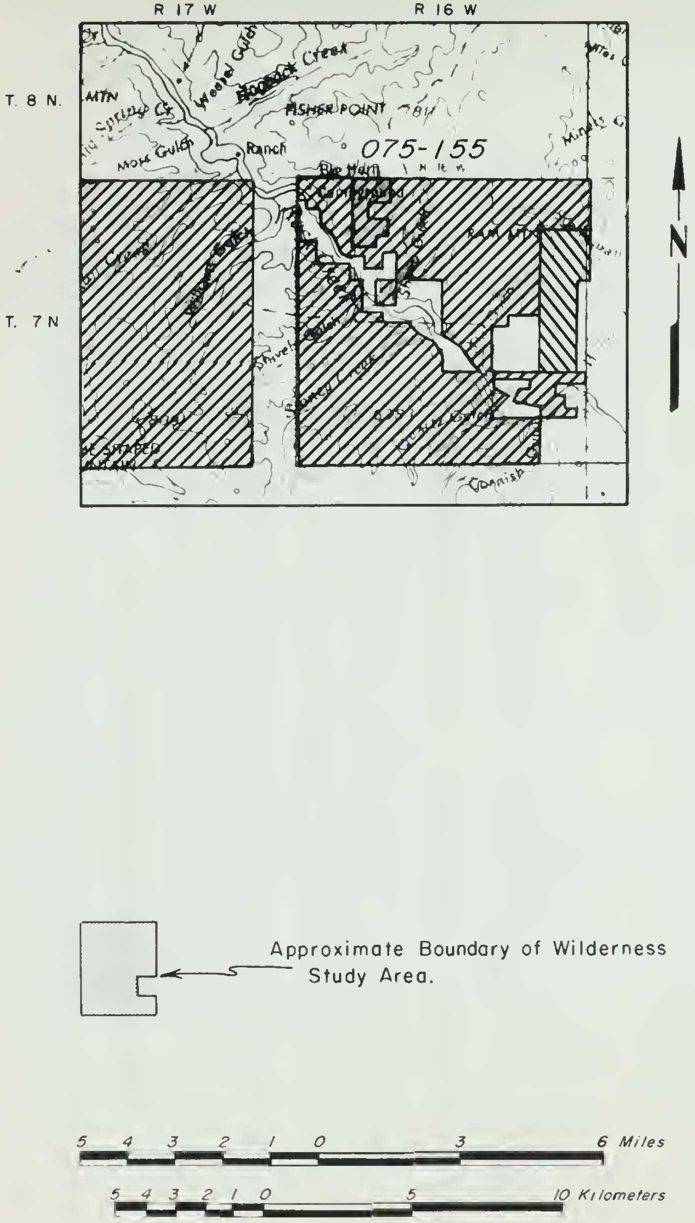
TABLE II

OIL AND GAS LEASE APPLICATIONS IN THE QUIGG WEST WSA, MONTANA

Application Number	Owner of Record	Date Filed
M51123	Arden R. Grover John R. Schumacher Box 3666 Midland, Texas 79702	May 15, 1981
M51146	Clem E. George 501 C&K Building Midland, Texas 79701	May 15, 1981

3.4 Mineral and Energy Deposit Types

The geologic setting of the Rock Creek GRA in relation to regional mineralization suggests that five additional types of mineralization might occur in the GRA. These include: (1) strataform copper in Beltian sedimentary rocks; (2) concordant silver-copper-tungsten bearing quartz veins; (3) contact metasomatic manganese or iron deposits, (4) porphyry copper deposits; and (5) intrusive-hosted gold bearing veins. Table III which follows, summarizes the mineral deposit types which have the best potential of occurring in the GRA.



▨ Lease Application

▨ Lease

Area of Research: T 7 N, R 16, 17 W
Data current to: August 4, 1982
Source of Data: BLM Status Plats

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana

Oil and Gas Lease Map

SCALE 1" = 4 MILES. (1 250,000)
DATA BY WGM DATE 9/1982 REVISED
DRWN BY DSI APRVD G.F
FIGURE 9

TABLE III

POTENTIAL MINERAL DEPOSIT TYPES IN THE ROCK CREEK GRA

Deposit Type	Commodities	Example
1. Steeply dipping quartz veins	Au, Ag, U ± Cu, Zn, Mo, W	Bagdad
2. Placer	Au	Miners-Scotchman Gulch
3. Copper in Belt sediments	Cu ± Ag	Troy plus numerous occurrences regionally
4. Concordant quartz veins	Ag-W ± Pb, Cu	Black Pine
5. Contact metamorphic	Mn, Fe	Philipsburg district
6. Porphyry	Cu	Butte district
7. Intrusive-hosted veins	Au	Miners Gulch area

Stratiform copper-silver mineralization is common in the green bed zone at the base of the Helena-Wallace Formation and also in parts of the Snowslip and upper Mt. Shields Formations throughout the Belt Basin (Harrison, 1972 and 1974; Clark, 1971). Since these units occur in the Rock Creek GRA there is potential for this type of mineralization.

The Black Pine mine, operated by Inspiration Development Company, is located about 12 miles northeast of the Rock Creek GRA. The deposit, discovered in 1882 (Walker, 1960) is a gently dipping, concordant quartz vein in Bonner quartzite (Volin et al., 1952). The vein averages six feet thick and contains about 10% sulfides, mainly tetrahedrite and pyrite with some galena and sphalerite. Hubnerite is a common constituent. The average ore grade is 6 ounces per ton silver, with dilution (Al Silva, pers. comm., 1982). The deposit, while grossly stratiform is structurally controlled and similar

mineralization could occur elsewhere in the region. The genesis of the Black Pine deposit is poorly understood, making exploration for similar deposits difficult (Appendix III).

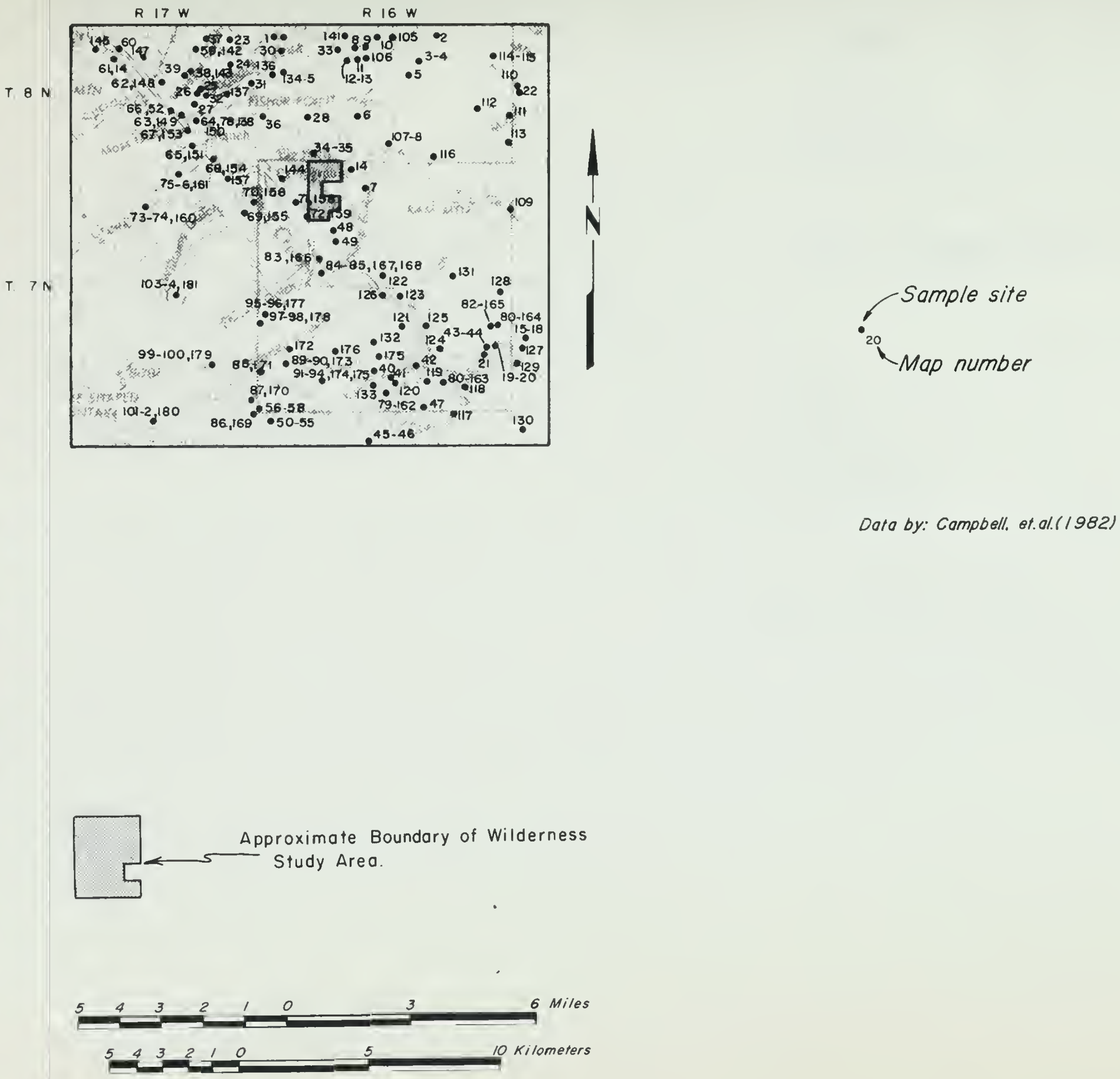
The manganese and iron deposits in the Philipsburg district are contact metamorphic deposits localized at the contact between carbonate units and the Philipsburg Batholith (Prinz, 1967). Since the Miners Gulch stock may be part of the same plutonic terrane as the Philipsburg Batholith (Hyndman et al., 1982) similar types of deposits could occur at the contacts of the intrusive bodies in the Rock Creek GRA.

The presence of crystalline placer gold in the gulches draining the Miners Gulch stock (Miners and Scotchman Gulch area) suggests that the stock may be auriferous. Pyrite-barite bearing quartz veins have also been reported in the area (James Miller, pers. comm., 1982). These factors suggest that there is potential in the Rock Creek GRA for lode gold mineralization associated with the intrusives.

Geochemical and geophysical data useful in assessing the mineral potential of the Rock Creek GRA include: (1) a NURE evaluation of the Butte Quadrangle (Broxton, 1980; Texas Instruments, Inc., 1979; Van Eeckout, 1980; Salisbury and Dietz, 1982) and (2) a study by the U.S. Geological Survey of the Butte Quadrangle as part of the CUSMAP program (Wallace et al., 1981 and Campbell et al., 1982). Aeromagnetic surveys by the U.S. Geological Survey have been completed but the data compilation is in progress (W.F. Hanna, oral comm., 1982). Similarly, a U.S. Geological Survey mineral resource

evaluation program has begun but considerable work remains (J.E. Elliott, oral comm., 1982).

Considerable geochemical data is available for the Butte Quadrangle from the NURE and CUSMAP programs. Water and stream sediment samples from Rock Creek and some of its tributaries within the GRA were collected during the NURE program. A review of this data shows that no water or stream sediment anomalies were detected in the Rock Creek GRA during the NURE sampling (Broxton, 1980 and Van Eeckout, 1980). A total of 181 samples including 58 rocks, 46 panned concentrates and 76 silt samples were collected in the Rock Creek GRA by the U.S. Geological Survey (Campbell et al., 1982). Four of these samples (71, 72, 158, 159) are from gullies which drain the Quigg West WSA (Fig. 10). The analytical data was evaluated qualitatively and is summarized in Table IV. Fifteen samples are considered to be anomalous in gold, silver, antimony, molybdenum, tin, barium or tungsten (Table V, Fig. 11). One of the samples (no. 71) is a panned concentrate from a stream which drains the Quigg West WSA. This sample contains over 10,000 ppm barium. Three panned concentrate samples (nos. 59, 61, 67) anomalous in gold, tin and tungsten occur in the northwest part of the GRA. Panned concentrate and stream silt samples from the southeastern part of the Rock Creek GRA are anomalous in gold, silver, barium and antimony. One panned concentrate sample (no. 85) from Shively Gulch, below some unpatented mining claims, is anomalous in gold and barium. A rock sample (no. 29) north of Hogback Creek in the north-central part of the GRA contains over two ounces per ton silver. Other rock samples from the southeastern part of the GRA are anomalous in gold, barium, molybdenum, antimony and silver. One rock


R 17 W
R 16 W
T. 8 N
T. 7 N
N
Sample site
20
Map number
Approximate Boundary of Wilderness Study Area.
5 4 3 2 1 0 3 6 Miles
5 4 3 2 1 0 5 10 Kilometers

Data by: Campbell. et.al.(1982)

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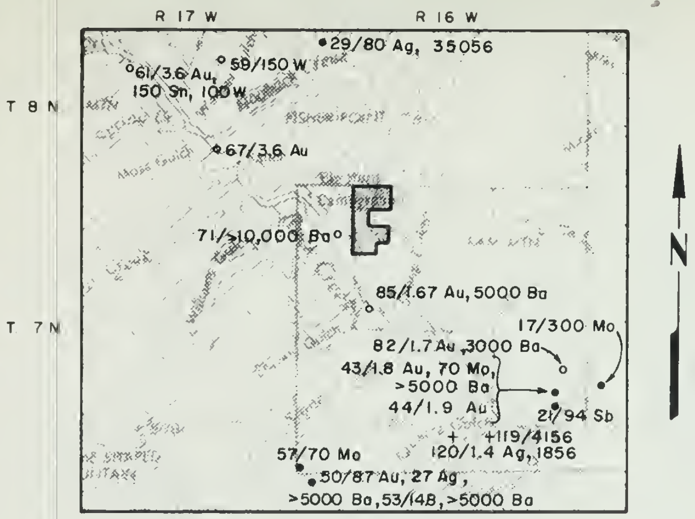
BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana U. S. Geological Survey Geochemical Sample Locations

SCALE 1" = 4 MILES (1 250,000)			FIGURE
DATA BY	DATE 9/1982	REVISED	10
DRWN BY DSI	APRVD G.F		



LEGEND

- ● *Rock Sample*
- + *Silt Sample*
- ○ *Panned Concentrate*

Sample No. — + 71/1.5Au — *Element concentration In PPM*

Au - *Gold*
Ag - *Silver*
Ba - *Barium*
Mo - *Molybdenum*
Sb - *Antimony*

Data by: Campbell, et.al. (1982)

▨ Approximate Boundary of Wilderness Study Area.

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BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana
Anomalous Geochemical Samples

SCALE 1" = 4 MILES (1:250,000)
DATA BY. DATE 9/1982 REVISED
DRWN BY DSI APRVD G.F
FIGURE 11

TABLE IV

SUMMARY OF U.S. GEOLOGICAL SURVEY GEOCHEMICAL RESULTS FOR THE ROCK CREEK GRA, MONTANA

	Typical Concentrations		
Element	Rock Samples	Panned Concentrates	Silt Samples
Au	0.5 ppm (A)	0.07 ppm (A)	ND (S)
Cu	20 ppm (A)	15 ppm (S)	25 ppm (A)
Pb	25 ppm (A)	30 ppm (S)	35 ppm (A)
Zn	10 ppm (A)	ND (S)	1 ppm (A)
Ag	3 ppm (A)	ND (S)	0.5 ppm (A)
Cd	1-7 ppm (A)	ND (S)	1 ppm (A)
Bi	ND (A)	ND (S)	1 ppm (A)
Sb	7 ppm (A)	ND (S)	1 ppm (A)
Mo	20 ppm (S)	ND (S)	ND (S)
Sn	ND (S)	ND (S)	ND (S)
W	ND (S)	10-30 ppm (S)	ND (S)
No. of samples	58	46	76

Notes:
1. Data from Campbell et al. (1982)
2. S - spetrographic analysis
   A - atomic absorption analysis
   ND - not detected
3. Summary based on qualitative review of data

TABLE V

ANOMALOUS GEOCHEMICAL SAMPLES, ROCK CREEK GRA, MONTANA

Sample No.	Type	Au (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ag (ppm)	Cd (ppm)	Bi (ppm)	Sb (ppm)	Mo (ppm)	Sn (ppm)	W (ppm)	Ba
17	RX	-	3	7	7	0.09	ND	2.0	2	300	ND	ND	700
21	RX	-	150	148	34	3.15	ND	38.0	94	7	ND	ND	300
29	RX	-	470	960	160	80.0	70.0	ND	35.0	15	ND	ND	100
43	RX	1.8	-	-	-	-	-	-	-	70	ND	<50	5,000
44	RX	1.9	-	-	-	-		-	-	10	ND	ND	1,500
50	RX	8.7	63	120	1	27.1	0.16	32.0	3	ND	ND	ND	>5,000
53	RX	14.8	1	ND	1	0.80	0.18	1.0	2	10	ND	ND	>5,000
57	RX	-	14	8	8	2.04	ND	2.0	2	70	ND	ND	700
59	PC	0.16	<10	<20	ND	ND	ND	ND	ND	ND	ND	150	2,000
61	PC	3.62	<10	20	ND	ND	ND	ND	ND	ND	ND		700
67	PC	3.50	10	70	ND	ND	ND	ND	ND	ND	150	100	300
71	PC	<0.05	<10	<20	ND	<1.0	ND	ND	ND	ND	ND	ND	>10,000
82	PC	2.70	<10	20	ND	ND	ND	ND	ND	ND	ND	ND	3,000
85	PC	1.67	10	<20	ND	ND	ND	ND	ND	ND	ND	ND	>5,000
119	SS	-	14	19	290	0.78	0.5	ND	41.0	ND	ND	ND	500
120	SS	-	7	110	104	1.4	1.4	ND	18.0	ND	ND	ND	300

Notes:
1. Data from Campbell et al. (1982).
2. Soectrographic and Atomic Absorption Analyses.
3. ND - not detected.

sample (no. 50) from the south-central part of the GRA contains about 0.25 ounces per ton gold and slightly less than one ounce per ton silver.

In the Rock Creek area, gold and barium anomalies show a strong correlation while silver and molybdenum anomalies show a weaker correlation. Thus the barium anomaly in sample no. 71 could indicate gold mineralization. Of particular interest is the lack of geochemical anomalies associated with the Bagdad mine and the occurrences on Miners and Scotchman Gulches. This may be due to sample distribution or it may indicate that geochemical dispersion is very limited in this area, a possibility that would enhance the significance of the anomalies detected. The geochemical data reviewed above tends to confirm the potential of vein-type mineralization.

The lack of copper anomalies suggests that the possibilities of porphyry copper mineralization or stratabound copper mineralization in Beltian rocks within the Rock Creek GRA is limited.

The lack of carbonate rocks in the stratigraphic section and similarly the absence of manganese occurrences or geochemical anomalies within the Rock Creek GRA suggests a limited potential for contact metamorphic manganese-iron deposits. The geochemical data alone is insufficient to fully evaluate the potential for these deposits, but there is also a paucity of carbonate rocks in the sedimentary section.

The uranium-thorium potential of the Rock Creek GRA must also be assessed in terms of the geologic environment as well as the NURE data. Three ore

environments, in about equal amounts, host 90% of the free world uranium reserves. These are:

1. early Precambrian quartz-pebble conglomerates,
2. sandstone-hosted roll-front deposits, mainly in post carboniferous continental sandstones, and
3. unconformity vein deposits, thus far known only in Proterozoic rocks.

Until the late 1960s, exploration emphasis was directed toward discovery of stratabound ores, in sandstone and in quartz-pebble conglomerate. Such deposits are still the source of most production. Vein deposits then known, although widespread and of high-grade, were generally small and in aggregate considered to be of lesser importance. However, the very important discoveries of the past 15 years, in northern Australia and in central Canada, comprise a distinctive type of pitchblende lode deposit described as unconformity veins. These deposits occur at or near the unconformity between lower and middle Proterozoic rocks. They are high-grade orebodies of variable sizes, and collectively account for about one-third of the western world's uranium reserves.

In the classical vein deposits, uranium is almost always accompanied by hematite and in the unconformity veins nickel, cobalt, and arsenic may be present. Sulphides of copper, lead, and molybdenum may occur in either type. Uranium in peneconcordant sandstone deposits is accompanied by iron (as pyrite if the ore is unoxidized) and in many cases by copper, molybdenum, selenium, and vandaium. This type of deposit accounts for about

95% of U.S. reserves. The second type of sedimentary deposits, the Precambrian conglomerates, are very large, but also very limited in distribution.

The lack of geochemical (Broxton, 1980) and geophysical (Texas Instruments, 1979) anomalies coupled with the unfavorable marine sedimentary environment present in the Rock Creek GRA suggests a limited potential for uranium mineralization in the GRA (Salisbury and Dietz, 1982).

No hydrocarbon production is known and no test wells have been drilled within the Rock Creek GRA. The nearest tests drilled (McCaslin, 1981b) are near Drummond, approximately 30 miles northeast, and Deer Lodge, approximately 36 miles east of WSA 075-155. Oil shows from Paleozoic or Mesozoic strata are known from some tests in these areas. Thus no direct data is available on the oil and gas resource potential of the GRA and it must be assessed on the basis of the favorability of geologic environment. According to Peterson (1981) the Rock Creek area would have been a part of the southern side of the Coeur'd Alene trough and should have received approximately 6,000 feet of Paleozoic marine sediments, and about 15,000 feet of Mesozoic (mainly Cretaceous) marine and non-marine sediments. He considers the Paleozoic and Mesozoic sediments of western Montana to have source and reservoir beds. Furthermore, Peterson (1981) states that: (1) the Precambrian sediments may have been buried so deeply that hydrocarbons were destroyed, (2) Devonian (395-345 m.y.) and younger Paleozoic and Mesozoic rocks were not altered beyond the early mature thermal stages, and (3) Cenozoic (65 m.y.-present) lake beds are of interest for their potential gas content. Paleozoic and Mesozoic sediments in the area encompassed by the

Rock Creek GRA could well be present in structurally lower thrust plates buried beneath the Rock Creek subplate. Surface reconnaissance geological mapping of the Rock Creek area does not indicate the presence of strata which known to be a hydrocarbon producers in the region.

In contrast to Peterson, Kranzler and Warne (1981) have provided hydrocarbon characterization analyses of Precambrian sediments in the southern part of the Elkhorn Mountains (approximately 85 miles east of the Rock Creek GRA) indicating that some of the Precambrian strata in western Montana are potential hydrocarbon source beds. Similar studies are needed in the Rock Creek GRA before source beds could be unquestionably recognized therein. The granitic stock present in the northeastern part of the Rock Creek GRA, decreases the hydrocarbon potential within the GRA. However, until the stratigraphy and structure of the Rock Creek area are better understood the area must be considered of possible but low favorability for the accumulation of oil and gas.

In the most recent geothermal classification of the United States (Muffler, 1979), geothermal resources were divided into six categories. These are:

1. Conduction-dominated regions
2. Igneous-related geothermal systems

3a. High temperature (over 150°C) hydrothermal convection systems

3b. Intermediate temperature (90-150°C) hydrothermal convection systems

4. Low temperature (less than 90°C) hydrothermal convection systems
5. Geo-pressured geothermal energy systems

For the purposes of this study the above classes can be reduced to two: (1) high temperature (over 150°C) hydrothermal convection systems, and (2) low/intermediate temperature (40-150°C) hydrothermal convection systems.

Based on present requirements for the use of hot fluids in electrical generating techniques, geothermal systems with temperatures of less than 150°C cannot be considered to have significant potential for electrical exploitation. Geothermal resources with temperatures less than 150°C can be considered to have a significant potential for low and intermediate temperature geothermal utilization for space heating, material processing, etc. if their minimum temperature exceeds 40°C. At the lower end of the spectrum, as the energy content of the resource becomes less, or the drilling depth necessary for exploitation becomes greater, there is a very ill-defined cutoff. For example, shallow ground water temperatures on the order of 10-20°C can be used for heat pump applications, and in some cases can be considered geothermal resources. However, for the purpose of this discussion, a lower temperature than approximately 40-60°C is considered uneconomic as a geothermal resource. Another economic factor affecting the viability of a geothermal resource is the distance from the source to the point of consumption. At lower temperatures it is not feasible to consider long distance transportation of geothermal energy whereas for the electrical grade resources long transportation distances are of course feasible.

Most geothermal exploitation to the present time has involved areas with surface manifestations. There are geothermal systems which may have no surface manifestations and are therefore "blind". An example of this sort of system exists in the Marysville mining district in central Montan

(Blackwell et al., 1975; Blackwell and Morgan, 1976). The area is near the Continental Divide and the bedrock is contact metamorphosed Precambrian Belt Series rocks underlain by Cretaceous and Cenozoic intrusive rocks. An area of approximately 50 square miles has a heat flow well above the regional background and at least half that area is underlain by a geothermal system with temperatures of approximately 100°C. The possibility of the existence of such systems is always present and cannot be ruled out without site-specific geothermal exploration data.

The absence of known thermal springs in the Rock Creek GRA means that the geothermal resource potential must be assessed on the basis of regional and local geologic setting. Western Montana and southern Idaho are included in the Cordilleran Mountain Belt of western North America. Volcanic and tectonic processes have been active in these areas within the past few millions of years and there are extensive manifestations at the surface of geothermal resources. However, within this area there are significant geographic variations. The area included in the GEM Region 2 can be divided into six provinces of different geothermal significance as shown in Table VI below.

TABLE VI

GEOTHERMAL PROVINCES IN GEM REGION 2

1. Montana Thrust/Foothills
2. Montana Basin and Range
3. Central Idaho Basin and Range
4. Idaho Batholith/Blue Mountains
5. Southeastern Idaho Basin and Range
6. Snake River Plains

The Rock Creek GRA is within the Montana Basin and Range province.

Although western Montana is classed physiographically as part of the Northern Rocky Mountains, the Cenozoic structural geology is similar to the Basin and Range province of the southwestern United States in that western Montana consists of north-northwest trending ranges separated by valleys which are controlled by horst and graben structures. The normal fault systems have been active in the Pliocene (6-2 m.y.) and Pleistocene (Pardee, 1950), and they currently form one of the major seismic zones in the western United States. This zone, the Intermountain Seismic Belt (Smith, 1978), more or less marks the eastern boundary of the Montana Basin and Range province. There has been no volcanic activity, however, in the province for apprroximately the past 30-35 m.y. Typical heat flow values in this province are 75 to 90 milliwatts per square meter (Blackwell, 1969; Blackwell and Robertson, 1973). Typical geothermal gradients range from 25° to 40°C/km and the data are reasonably complete on a reconnaissance basis for this province.

There are numerous hot springs in southwestern Montana. These have been discussed in some detail by Robertson et al. (1976) and are shown on the resource map by Sonderegger and Bergantino (1981). Geochemical reservoir temperatures and measured surface temperatures of these systems generally indicate maximum temperatures between 75° to 150°C. Typically, these hot springs are associated with major fracture zones in granitic plutons or with major fracture/fault zones such as the range-bounding faults (especially when major cross structures intersect these zones). The available data suggest that the likelihood of electrical grade temperature (over 150°C) resources in this province is small. On the other hand, on a relative

basis, the low/moderate temperature resources in the area are significant based on the presence of many hot and warm springs.

Summarizing, most of the geothermal systems in Rock Creek region are associated with major lineament/fracture zones where deep circulation is possible. The Rock Creek GRA is not near any major range bounding normal faults; but it does include the valley of Rock Creek - a major topographic lineament. The Quigg West WSA is mostly at higher elevations above the valley and probably above any upflow system that might occur in the valley of Rock Creek. The nearest geothermal data consist of a heat flow measurement in the Black Pine Range about 10 miles east of the WSA and geothermal gradients measured in NURE exploration holes that penetrated Cenozoic rocks of the Bitter Root Basin (immediately to the west of the mountains). The heat flow value in the Black Pine Range is 80 milliwatts per square meter and the gradient is 18°C/km (1°F/100 ft.; Blackwell and Robertson, 1973), typical of those in the Montana Basin and Range province. Gradients in the low conductivity basin sediments present in the Bitterroot Basin range from 25-35°C/km (1.4-1.9°F/100 ft.) so the heat flow values there are also typical (Leonard, 1979). The closest hot spring to the Rock Creek GRA is Sleeping Child Hot Spring about 25 miles south. The hot spring issues at 52°C from granitic rocks of the Idaho Batholith in the valley of Sleeping Child Creek. It has a maximum estimated reservoir temperature of 125°C (Sonderegger and Bergantino, 1981).

3.5 Mineral and Energy Economics

The Rock Creek GRA is near the Philipsburg mining district which has had a long and productive history (Emmons and Calkins, 1913; Prinz, 1967). The

region is one of the most highly mineralized areas in the world (Elliot, pers. comm., 1982) and is being actively explored by mining companies and prospectors today. The data reviewed in the previous sections suggests that the greatest potential for GEM Resources in the Quigg West WSA is for placer and lode deposits of precious metals; therefore the general discussion of mineral economics given below is confined to these commodity/deposit types.

The rise in the prices of silver and gold in the past decade has spurred massive exploration efforts and led to the development of many deposits which were previously uneconomic. It is forecast that domestic mine production will supply only about one-third of United States demand for primary gold through the year 2000, with about two-thirds of mined gold coming from gold deposits and the remainder produced as by-products of base metal mining (Butterman, 1980). The consequent demand for gold and present high price levels make domestic gold deposits attractive. Modern high productivity heavy equipment has lead to a reduction in placer mining costs and resultant revival of old placer districts in many parts of the United States. For these reasons the gold in the Tertiary gravels in the eastern part of the Rock Creek GRA have been examined by several mining companies in recent years (E. Miller, pers. comm., 1982). If similar mineralization is present in the Tertiary gravels within the Quigg West WSA, the proximity of the deposits to a source of water and to the Rock Creek road would make them particularly attractive.

In addition to placer deposits, gold and silver may be present in lode deposits. The United States currently imports over 50% of its silver and is expected to continue to do so if future supply-demand relationships follow

present trends (Drake, 1980; Rosta, 1982). A lode silver mine, the Black Pine Mine is located 12 miles northeast of the Quigg West WSA (Appendix III). The mine produces silver from a 5-10 foot thick concordant vein. The ore averages 5.59 ounces of silver per short ton and 0.6% copper (Silva, pers. comm., 1982). Mining is at a rate of 1,000 to 1,200 tons per day by room and pillar method using trackless equipment. Previously the ore was shipped directly to the ASARCO smelter in Helena. In 1981 a custom mill opened in in Philipsburg contributing to a lowering of operating costs and resulting in increased production. Any lode silver, gold, or base metals produced from the WSA could also be treated at the Philipsburg mill.

In summary, current price-demand trends for precious metals coupled with the nearby water source, access road and mill would increase the economic viability of any mineralization which might be present in the Quigg West WSA.

Both silver and copper which occur in vein deposits in and near the Rock Creek GRA are considered strategic minerals. Tungsten, which is also a strategic mineral, is a by-product of many veins in the Rock Creek region.

4.0 LAND CLASSIFICATION FOR GEM RESOURCES POTENTIAL

4.1 Explanation of Classification Scheme

In the following section the land in the Quigg West WSA is classified for geology, energy and mineral (GEM) resources potential. The classification scheme used is shown in Table VII. Use of this scheme is specified in the contract under which WGM prepared this report.

The evaluation of resource potential and integration into the BLM classification scheme has been done using a combination of simple subjective and complex subjective approaches (Singer and Mosier, 1981) to regional resource assessment. The simple subjective approach involves the evaluation of resources based on the experience and knowledge of the individuals conducting the evaluations. The complex subjective method involves use of rules, i.e. geologic inference, based on expert opinion concerning the nature and importance geologic relationships associated with mineral and energy deposits (Singer and Mosier, 1981; Table II).

The GEM resource evaluation is the culmination of a series of tasks. The nature and order of the tasks was specified by the BLM, however they constitute the general approach by which most resource evaluations of this type are conducted. The sequence of work was: (1) data collection, (2) compilation, (3) evaluation, and (4) report preparation. No field work was done in the Quigg West WSA itself, however WGM geologists visited the gold placers in the eastern part of the Rock Creek GRA and the Black Pine Mine.

TABLE VII

BUREAU OF LAND MANAGEMENT GEM RESOURCES LAND CLASSIFICATION SYSTEM

CLASSIFICATION SCHEME

1. The geologic environment and the inferred geologic processes do not indicate favorability for accumulation of mineral resources.
2. The geologic environment and the inferred geologic processes indicate low favorability for accumulation of mineral resources.
3. The geologic environment, the inferred geologic processes, and the reported mineral occurrences indicate moderate favorability for accumulation of mineral resources.
4. The geologic environment, the inferred geologic processes, the reported mineral occurrences, and the known mines or deposits indicate high favorability for accumulation of mineral resources.

LEVELS OF CONFIDENCE

A. The available data are either insufficient and/or cannot be considered as direct evidence to support or refute the possible existence of mineral resources within the respective area.

B. The available data provide indirect evidence to support or refute the possible existence of mineral resources.

C. The available data provide direct evidence, but are quantitatively minimal to support or refute the possible existence of mineral resources.

D. The available data provide abundant direct and indirect evidence to support or refute the possible existence of mineral resources.

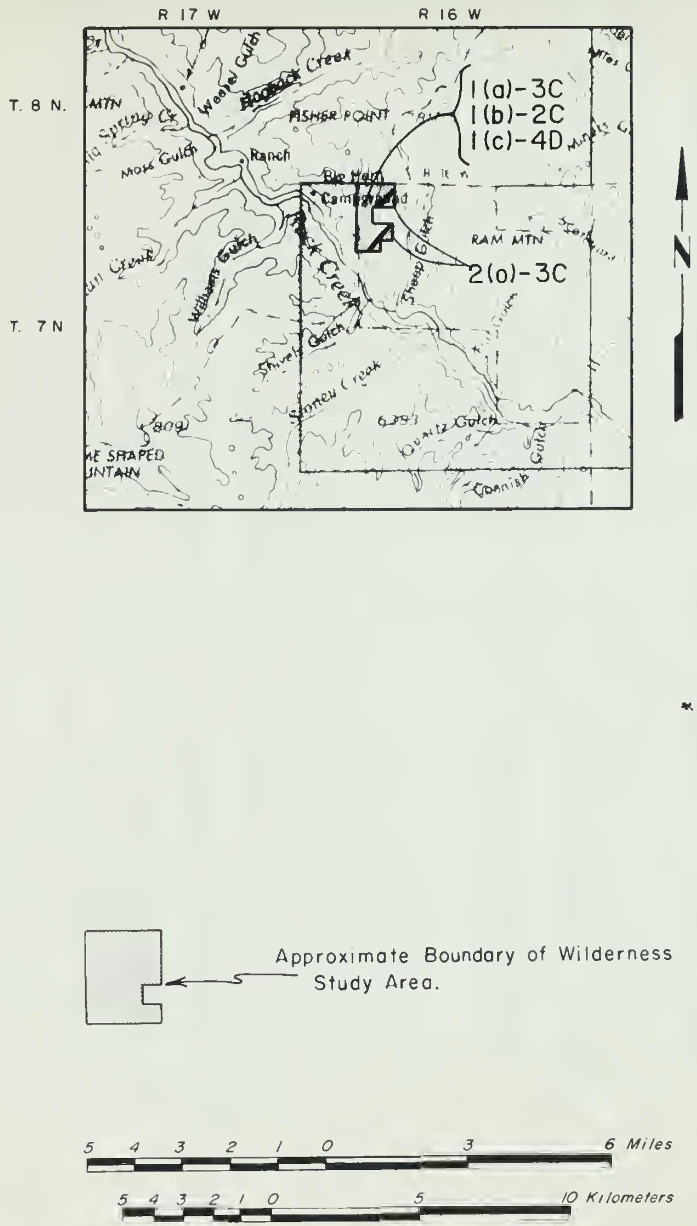
4.2 Classification of the Quigg West (075-155) Wilderness Study Area

4.2.1 Locatable Minerals

Locatable minerals are those which are locatable under the General Mining Law of 1872, as amended, and the Placer Act of 1870, as amended. Minerals which are locatable under these acts include metals, ores of metals, nonmetallic minerals such as asbestos, barite, zeolites, graphite, uncommon varieties of sand, gravel, building stone, limestone, dolomite, pumice, pumitice, clay, magnesite, silica sand, etc. (Maley, 1980).

4.2.1a Metallic Minerals. Based on limited direct evidence, the entire area of WSA 075-155 (1a, Fig. 12) is classified as having moderate favorability for metallic minerals (3C) - specifically vein-type silver and/or gold mineralization. The basis of the classification is the presence of numerous gold and silver bearing veins throughout the region in host rocks and structural settings similar to that of the Quigg West WSA. In addition, a U.S. Geological Survey panned concentrate sample collected in a drainage below the WSA is strongly anomalous in barium. Barite is often associated with gold-silver veins in the region.

The portion of the WSA covered by Tertiary gravels (2a, Fig. 12) is classified as having moderate favorability for placer gold based on limited direct evidence (3C). The basis of the classification is the presence of placer gold in similar gravels in the eastern part of the Rock Creek GRA.



BLM LAND CLASSIFICATION SYSTEM FOR GEM RESOURCES

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

LEVELS OF CONFIDENCE

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVLEY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

EXPLANATION

1(a)- 4D
Area I.D. Number
Commodity
Classification
Level of Confidence

a) Metallic Minerals
b) Uranium and Thorium
c) Non-Metallic Minerals

WGM Inc. Mining and Geological Consultants
Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana
Wilderness Study Area
Land Classification
Locatable Resources

SCALE 1" = 4 MILES (1:250,000)			FIGURE
DATA BY WGM	DATE 9/1982	REVISED	12
DRWN BY DSI	APRVD GF		

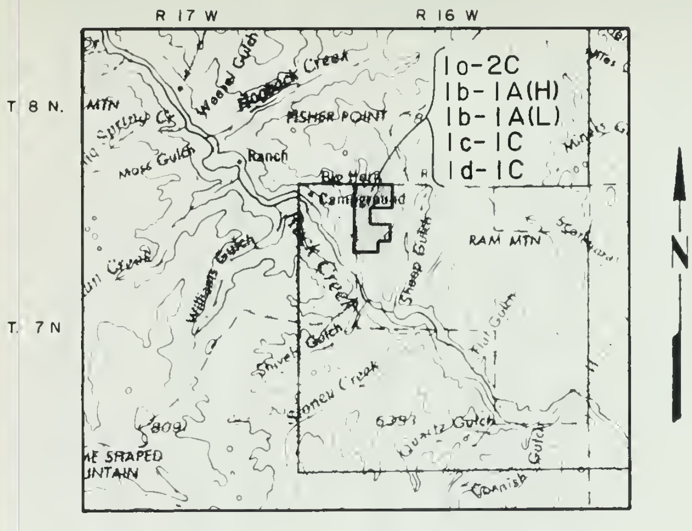
4.2.1b Uranium and Thorium. All of WSA 075-155 (1b, Fig. 12) is classified as having low favorability for uranium and thorium based on limited direct evidence (2C). The basis of this classification is the marine origin of the bedrock, and the absence of geochemial and radiometric anomalies in the NURE data for the area.

4.2.1c Non-Metallic Minerals. The entire area of WSA 075-155 (1c, Fig. 12) is classified as having moderate favorability for barite based on limited direct evidence (3C). This classification is based on the occurrence of barite in veins in the region and the strong barium geochemical anomaly in the Quigg West WSA.

4.2.2 Leasable Resources

Leasable resources include those which may be acquired under the Mineral Leasing Act of 1920 as amended by the Acts of 1927, 1953, 1970, and 1976. Materials covered under this Act include: asphalt, bitumen, borates and sodium and potassium, carbonates of sodium and potassium, coal, natural gas, nitrates of sodium and potassium, oil, oil shale, phosphate, silicates of sodium and potassium, sulfates of sodium and potassium, geothermal resources, etc. (Maley, 1980).

4.2.2a Oil and Gas. The entire area of WSA 075-155 (1a, Fig. 13) is classified as having low favorability for oil and gas based on limited direct evidence (2C). The classification is based on the geologic setting of the WSA as compared with known hydrocarbon producing areas in the Overthrust Belt and on the data and discussion in section 3.4.



BLM LAND CLASSIFICATION SYSTEM FOR GEM RESOURCES

CLASSIFICATION SCHEME

1. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES DO NOT INDICATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

LEVELS OF CONFIDENCE

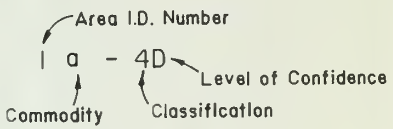
A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVLEY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

EXPLANATION



a) oil and gas

b) Geothermal: high temperature (H), Low temperature (L)

c) Sodium and Potassium

d) other: Asphalt (As) bitumen (bt), phosphate (ph), No specific commodity designation indicates that the rating applies to all of the above.

Approximate Boundary of Wilderness Study Area.

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Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana

Wilderness Study Area
Land Classification
Leasable Resources

SCALE 1" = 4 MILES (1 250,000)		REVISED	FIGURE
DATA BY WGM	DATE 9/1982		13
DRWN BY DSI	APRVD G.F.		

4.2.2b Geothermal. The entire area of WSA 075-155 (1b, Fig. 13) is classified as unfavorable for both low and high temperature geothermal resources, but the data is not sufficient for an adequate evaluation (1A). The regional and local setting provide evidence against the presence of geothermal resources in the Quigg West WSA, but more geochemical or geothermal gradient data is necessary to fully evaluate this parcel of land.

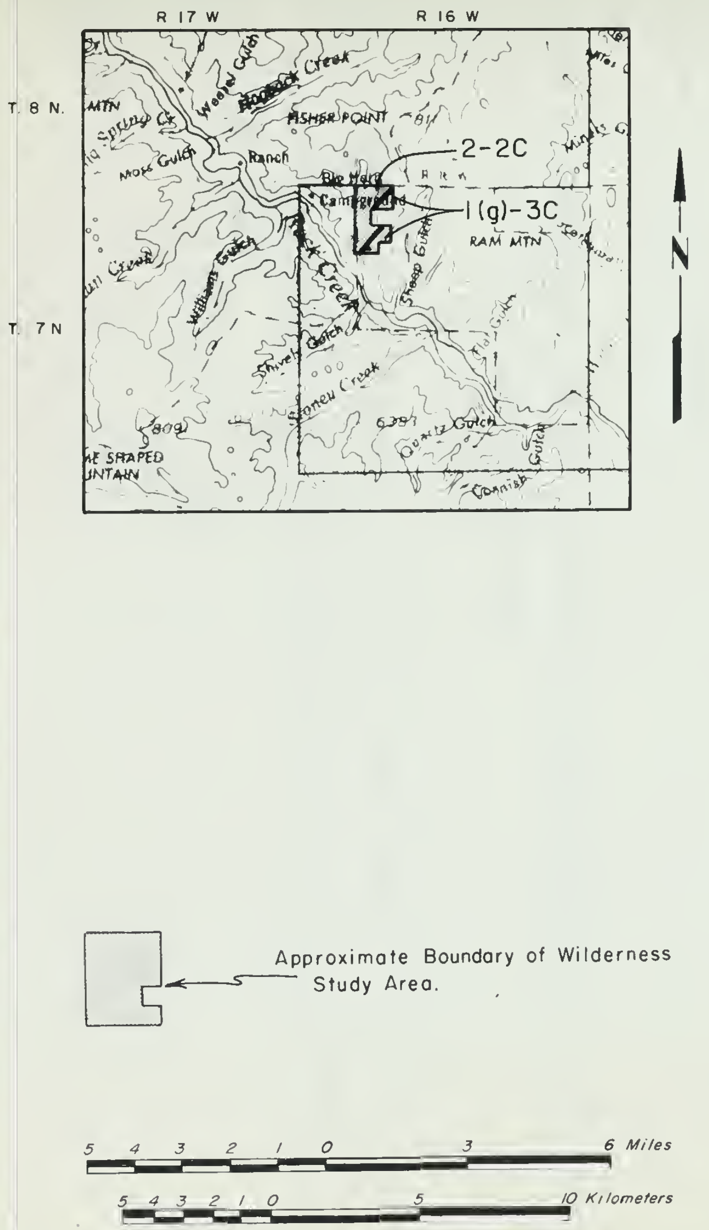
4.2.2c Sodium and Potassium. The entire area of WSA 075-155 (1c, Fig. 13) is classified as unfavorable for sodium and potassium based on limited direct evidence (1C). The classification is based on the nature of the geologic environment in the WSA.

4.2.2d Other. The entire area of WSA 075-155 (1d, Fig. 13) is classified as unfavorable for other leasable resources including asphalt, bitumen and phosphate based on limited direct evidence (1C).

4.2.3 Saleable Resources

Saleable resources include those which may be acquired under the Materials Act of 1947 as amended by the Acts of 1955 and 1962. Included under this Act are common varieties of sand, gravel, stone, cinders, pumice, pumicite, clay, limestone, dolomite, peat and petrified wood (Maley, 1980).

The portion of WSA 075-155 which is covered by Tertiary gravels (1, Fig. 14) is classified as moderately favorable for gravel resources based on limited direct evidence (3C). The remainder of the WSA is classified as having low favorability for other saleable resources based on limited direct evidence (2C).



BLM LAND CLASSIFICATION SYSTEM FOR GEM RESOURCES

CLASSIFICATION SCHEME

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2. THE GEOLOGIC ENVIRONMENT AND THE INFERRED GEOLOGIC PROCESSES INDICATE LOW FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
3. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, AND THE REPORTED MINERAL OCCURRENCES INDICATE MODERATE FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.
4. THE GEOLOGIC ENVIRONMENT, THE INFERRED GEOLOGIC PROCESSES, THE REPORTED MINERAL OCCURRENCES, AND THE KNOWN MINES OR DEPOSITS INDICATE HIGH FAVORABILITY FOR ACCUMULATION OF MINERAL RESOURCES.

LEVELS OF CONFIDENCE

A. THE AVAILABLE DATA ARE EITHER INSUFFICIENT AND/OR CANNOT BE CONSIDERED AS DIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES WITHIN THE RESPECTIVE AREA.

B. THE AVAILABLE DATA PROVIDE INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

C. THE AVAILABLE DATA PROVIDE DIRECT EVIDENCE, BUT ARE QUANTITATIVLEY MINIMAL TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

D. THE AVAILABLE DATA PROVIDE ABUNDANT DIRECT AND INDIRECT EVIDENCE TO SUPPORT OR REFUTE THE POSSIBLE EXISTENCE OF MINERAL RESOURCES.

EXPLANATION

Area I.D. Number
1(1s) - 4D
Commodity
Classification
Level of Confidence

s	Sand
g	Gravel
st	Stone
c	Cinders
p	Pumice
pt	Pumicite
cl	Clay
Ls	Limestone
dl	Dolomite
P	Peat
pw	Petrified wood

WGM Inc. Mining and Geological Consultants
Anchorage, Alaska

BLM GEM RESOURCES ASSESSMENT
REGION 2 NORTHERN ROCKY MOUNTAINS

Rock Creek GRA, Montana
Wilderness Study Area
Land Classification
Saleable Resources

SCALE 1" = 4 MILES (1 250,000)
DATA BY WGM | DATE 9/1982 | REV SED
DRWN BY DSI | APRVD G.F
FIGURE 14

5.0 RECOMMENDATIONS FOR FURTHER WORK

The anomalous panned concentrate sample collected by the U.S. Geological Survey (no. 71, Table V) should be confirmed by resampling at the same location. If the anomaly can be reproduced the drainage basin should be mapped at 1 inch to 1,000 feet scale to locate possible vein mineralization. The source of the rock samples (no. 29) containg two ounces of silver per ton should also be examined.

The extent of the Tertiary gravels in the Quigg West WSA should be mapped at a 1:24,000 scale to ascertain their extent. If the gravels occur in the WSA, pits dug to bedrock should be sampled to test for placer gold. The geologists who perform the sampling should first visit the placers on Miners-Scotchman Gulch to better understand the nature of the gold distribution. J.C. Antweiler of the U.S. Geological Survey has mapped the Miners-Scotchman Gulch placers in detail. His data, as yet unpublished should be used to guide the sampling program.

Four recommendations are made to perform a thorough evaluation of the hydrocarbon potential of the Quigg West WSA:

1. Detailed geologic mapping of the area should be done. This will provide an understanding of the stratigraphic section and structure of the area.

2. Hydrocarbon and reservoir characterization studies of the stratigraphic units of the area should be undertaken to identify units which may be potential source and reservoir beds.

3. Thermal maturation studies should be completed on any potential source beds. This will indicate the type of hydrocarbons to be expected within the area.

4. A seismic survey of the area should be made to aid in interpretation of subsurface structures and their relationship to surface structures. It could help ascertain whether or not Paleozoic and Mesozoic sediments are present beneath the surface thrust plates.

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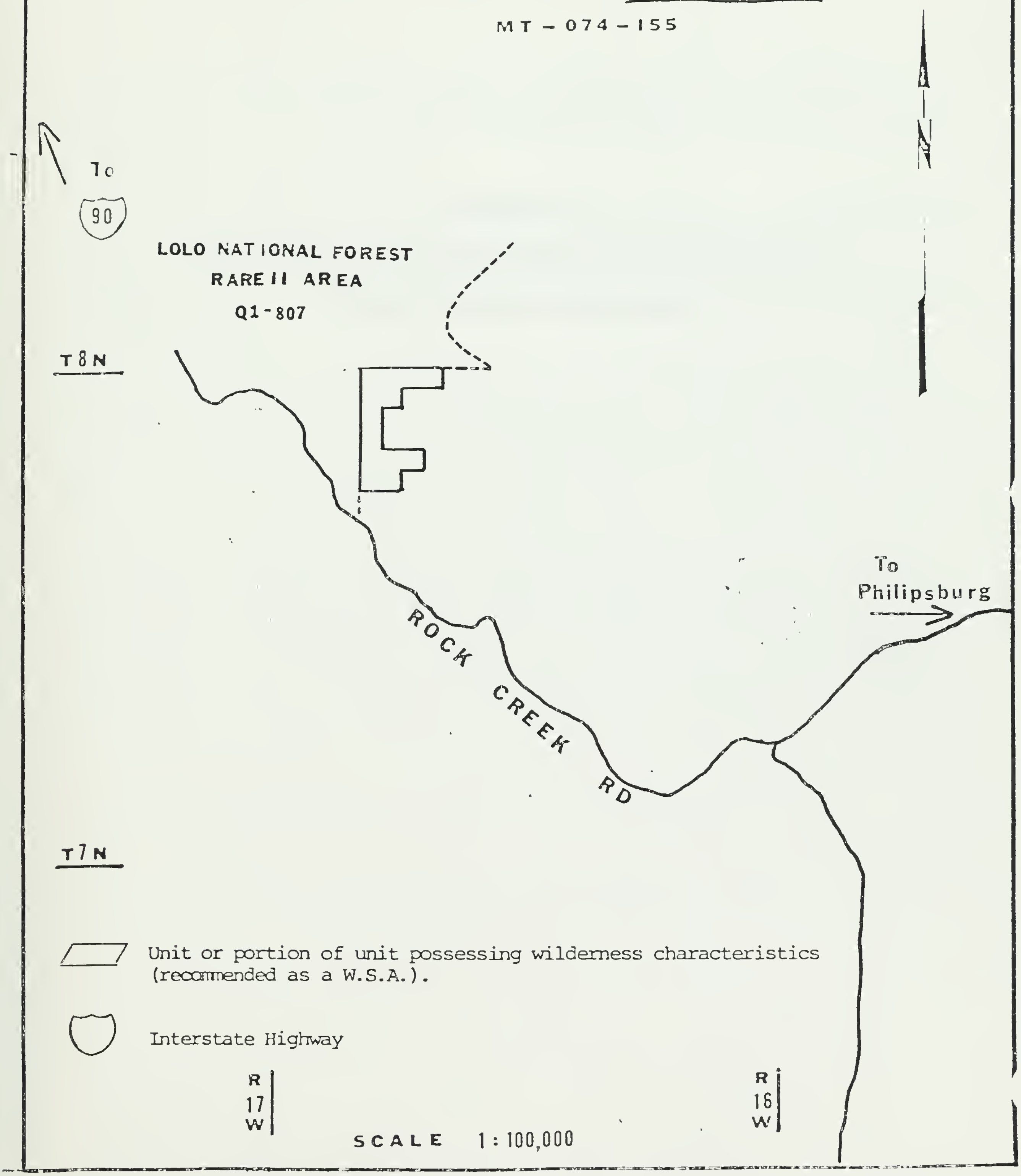
APPENDIX I

WILDERNESS STUDY AREA MAPS

FINAL DECISION

QUIGG WEST TACK-ON

MT-074-155



APPENDIX II

TRIP REPORTS FOR VISITS TO THE BLACK PINE MINE AND GOLD PLACERS ON MINERS GULCH

To: Rock Creek GRA File
Fm: Greg Fernette, Bill Jones

Subject: Visit to Miners Gulch Gold Placers

On October 20, 1982, at the conclusion of the field verification task of the GEM Project we visited Everett Miller's gold placers on Miners Gulch, west of Philipsburg, Montana. The visit was at Mr. Miller's invitation and he accompanied us to the property. We thought the visit might be of value in the Rock Creek GRA evaluation.

We visited Scotchman Gulch, Miners Gulch and No Name Gulch. These areas are underlain by Cretaceous granodiorite known as the Miners Gulch stock. Bedrock in the area is largely covered by Tertiary lake and stream sediments. Where exposed the granodiorite does show alteration and quartz-barite-pyrite veins. Samples of the vein material are anomalous in gold, zinc, and copper.

We collected nine pan samples, three at each stop. The samples were from well stratified, moderately sorted, rusty gravel. The sediment section in each location was similar: granodiorite grus, overlain by two to ten feet of sand and gravel, overlain by three to ten feet of sand, silt and some gravel. The gold tended to be in sand and gravel layers above the weathered bedrock but not in the bedrock.

We found gold in eight of the nine samples. The minimum was three tiny colors and the maximum was over 50. The gold tends to be very fine but there also is some fine crystalline and wire gold. These grains are 1-2 mm long. The crystal faces are well preserved indicating either a short transport distance or in-situ growth. The age and genesis of the deposits is not clear. The host gravels may be Tertiary but there is no good age evidence. In addition, the gold may have been transported or have grown in-situ. If the latter why the gold only occurs in one strata is a question that needs answering.

Jack Antweiler of the USGS has been studying the deposits and is expected to release a report on them soon.

Everett Miller mined 150 cubic yards from the Sawpit area on Scotchman Gulch last year but did not say how much gold he recovered. He plans to option the property to a company or syndicate to mine it.

To: Rock Creek GRA File
Fm: Greg Fernette, Bill Jones

Subject: Visit to Black Pine Mine

On October 20, 1982, we visited the Black Pine Mine located about 15 miles northwest of Philipsburg, Montana. This was an informal visit made at the invitation of the mine geologist, Al Silva, which we thought might have some bearing on the Rock Creek and Garnet GRA evaluations.

The mine is owned and operated by Inspiration Development Company; they began operation in 1974 at 300 st./d. Through 1981 they had shipped a total of 411,000 tons with an average grade of 5.59 oz/t silver and 0.6% copper. The ore was shipped directly to the ASARCO smelter in Helena. They decided to increase production when silver prices went up, but would have needed a mill to exploit lower grade ore. In 1981 a custom mill opened in Philipsburg. Inspiration studied the alternatives of using the custom mill versus building their own and opted to use the contract mill. They increased production to 1,000 st./d and are now operating at 1,200 st./d.

The deposit is a relatively flat-lying, concordant quartz vein ranging from two to ten feet thick, and averaging 5-6 feet.

The vein dips about 6° and pinches and wells. In general it follows the bedding in the quartzite. The vein is displaced by normal faults with throws of 10 to 20 feet. The vein is hosted by Bonner quartzite unit in the Belt Supergroup. The Bonner is underlain by Mt. Shields Formation and overlain by McNamara Shale. The host rocks are brown, thin- to medium-bedded quartzite. The vein is mainly white quartz which shows several generations of open-space filling texture. The vein averages 10% sulfides: pyrite and tetrahedrite, with lesser sphalerite, galena, and chalcopyrite. Hubnerite is an important accessory. Their current average grade is 6 oz/t silver with dilution. They have at least 10 years ore blocked out and are open in three directions.

The ore is concentrated by bulk flotation to produce a silver-copper concentrate. Hubnerite is recovered by gravity separation from the flotation tailings.

They mine by room and pillar method using trackless equipment Access is via a decline. The minimum mining width is six feet with 15 foot wide rooms and 8x8 foot pillars. Development headings are 10x15 feet. All work is done on the vein. The back has to be bolted. Eimco 912 scooptrams are used for mucking. Stope rounds are drilled with jacklegs and development rounds with hydraulic jumbos. They maintain 12-15 working areas at a time. Ore is stockpiled at the base of the decline where it is mixed and remucked. Four 20 ton Eimco trucks (two for haulage up the decline) are used for haulage. A Cat 950 load is used to load trucks to haul ore to the mill.

The mine employs 60 people, including 28 miners on three shifts. The workers are non-union. A day shift miner makes $11.59/hr. plus a round bonus. Current productivity is 34 tons per man-shift.

APPENDIX III

U.S. GEOLOGICAL SURVEY GEOCHEMICAL DATA FOR THE ROCK CREEK GRA, MONTANA

LATITUDE 46°00'-46°30' LONGITUDE 113°30'-114°00'

TABLE 1. ROCK SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1°x2° CUSMAP QUADRANGLE, MONTANA (continued)

map #	SAMPLE	LATITUDE	LONGITUDE	S-FE%	S-MG%	S-CA%	S-TI%	S-MN	S-AG	S-AS	S-AU	S-B	S-BA	S-BE
1	80635	46 26 20	113 39 31	1.50	.70	<.05	.200	70	N	N	N	100	500	1.5
2	ALD0137R	46 26 30	113 34 57	1.50	.30	<.05	.150	200	N	N	N	500	500	2.0
3	ALD0138R	46 25 56	113 35 23	3.00	1.50	.30	.500	300	N	N	N	500	500	3.0
4	ALD0139R	46 25 48	113 35 24	2.00	.70	1.50	.300	700	N	N	N	70	2,000	2.0
	ALD0140R	46 25 31	113 35 42	.70	.20	<.05	.100	50	N	N	N	70	500	1.5
6	ALD0142R	46 24 39	113 37 6	1.50	.70	.10	.150	1,000	N	N	N	150	500	2.0
7	ALD0144R	46 23 14	113 36 51	2.00	1.00	.15	.300	300	N	N	N	200	500	1.5
	ALD0524R	46 26 5	113 37 12	3.00	1.00	.30	.300	300	N	N	N	300	1,500	3.0
9	ALD0525R	46 26 14	113 36 55	3.00	.70	.15	.300	200	N	N	N	300	700	2.0
10	ALD0526R	46 26 19	113 36 43	3.00	1.00	.15	.500	200	N	N	N	300	1,000	3.0
11	ALD0539R	46 25 49	113 37 5	2.00	1.00	.10	.100	100	N	N	N	50	500	3.0
12	ALD0540R	46 25 46	113 37 17	>20.00	.20	<.05	.020	1,000	N	N	N	10	500	1.0
13	ALD0541R	46 25 47	113 37 27	3.00	.70	.20	.500	150	N	N	N	300	500	5.0
	ALD1221R	46 23 35	113 37 16	.70	.15	.10	.150	20	N	N	N	10	700	1.5
15	COG3315R	46 20 2	113 32 5	2.00	<.02	.30	.002	300	<.5	N	N	N	5,000	N
16	COG3316R	46 20 2	113 32 5	3.00	1.50	10.00	.200	300	N	N	N	50	500	1.5
17	COG3317R	46 20 3	113 32 2	5.00	.15	3.00	.003	700	N	N	N	10	700	7.0
18	COG3318R	46 20 3	113 32 2	2.00	3.00	10.00	.150	500	N	N	N	N	500	1.5
19	COG3321R	46 19 54	113 33 10	3.00	.02	.07	.030	100	N	N	N	<10	>5,000	1.5
	COG3322R	46 19 54	113 33 10	1.00	1.00	.15	.300	70	N	N	N	50	300	3.0
21	COG3323R	46 19 49	113 33 16	5.00	.30	1.00	.150	300	5.0	500	N	70	300	2.0
22	E0037A	46 25 10	113 32 18	1.50	1.50	1.50	.150	500	N	N	N	N	1,000	2.0
23	QUI0126R	46 26 21	113 40 52	2.00	1.00	.30	.300	300	N	N	N	200	1,000	3.0
24	QUI0127R	46 25 45	113 40 54	3.00	.50	.50	.300	300	N	N	N	300	1,000	3.0
25	QUI0128R	46 25 8	113 41 45	1.00	.20	.10	.070	700	N	N	N	70	5,000	2.0
	QUI0129R	46 25 1	113 41 59	3.00	.70	.10	.500	150	1.0	N	N	200	1,000	2.0
27	QUI0130R	46 24 53	113 41 57	2.00	.50	.07	.150	50	10.0	N	N	150	1,000	3.0
	QUI0143R	46 24 38	113 38 38	1.50	1.00	.30	.300	300	N	N	N	300	1,000	2.0
	QUI0513R	46 26 25	113 39 28	3.00	.03	<.05	.002	300	70.0	N	N	10	100	N
	QUI0515R	46 26 1	113 39 29	2.00	.05	.05	.003	200	<.5	N	N	<10	70	<1.0
31	QUI0519R	46 25 18	113 40 14	2.00	.70	3.00	.200	500	N	N	N	150	3,000	2.0
32	QUI0520R	46 25 6	113 40 41	.50	.07	.10	.050	700	N	N	N	10	500	<1.0
33	QUI1217R	46 26 7	113 37 40	3.00	1.50	.20	.300	100	N	N	N	300	500	2.0
34	QUI1218R	46 23 54	113 38 28	2.00	1.50	.20	.300	500	N	N	N	150	2,000	1.5
35	QUI1219R	46 23 54	113 38 28	2.00	.20	.07	.200	150	N	N	N	50	1,500	1.5
	QUI1220R	46 24 42	113 39 55	1.50	.30	.30	.200	300	N	N	N	200	1,500	2.0
37	QUI1822R	46 26 19	113 41 32	3.00	1.50	2.00	.500	300	N	N	N	200	1,000	2.0
38	QUI1825R	46 25 36	113 42 3	1.00	1.50	3.00	.200	1,000	N	N	N	150	2,000	1.5
	QUI1827R	46 25 30	113 42 11	5.00	.03	.07	.005	200	5.0	N	N	10	>5,000	1.0
40	S0042A	46 19 25	113 36 35	1.50	.20	<.05	.100	50	N	N	N	100	150	1.5
41	S0043A	46 19 15	113 36 5	5.00	.15	<.05	.100	20	<.5	N	N	150	700	2.0
42	S0044A	46 19 30	113 35 25	5.00	.20	.50	.100	200	2.0	700	N	200	500	1.5
43	S0074A	46 19 50	113 33 15	5.00	.07	1.00	.020	150	1.0	300	N	10	>5,000	3.0
	S0075A	46 19 50	113 33 15	2.00	.15	3.00	.050	200	N	N	N	<10	1,500	2.0
45	S0079A	46 18 0	113 36 45	1.50	.07	<.05	.100	10	70.0	500	N	100	200	1.0
	S0080A	46 18 0	113 36 45	1.00	.05	<.05	.070	10	50.0	N	N	70	100	1.5
47	S0081A	46 18 40	113 35 10	2.00	.30	2.00	.300	300	N	N	N	200	700	2.0

TABLE1. ROCK SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1 x2 CUSMAP QUADRANGLE,MONTANA(continued)

MAP #	SAMPLE	S-BI	S-CD	S-CO	S-CR	S-CU	S-LA	S-MO	S-NB	S-NI	S-PB	S-SB	S-SC	S-SN	S-SR	S-V	S-W
1	80635	N	N	7	20	<5	20	N	N	10	10	N	<5	N	N	30	N
2	ALD0137R	N	N	N	15	<5	20	N	N	10	20	N	5	N	N	30	N
3	ALD0138R	N	N	10	100	<5	50	N	<20	50	15	N	7	N	N	70	N
4	ALD0139R	N	N	5	<10	<5	30	N	<20	7	30	N	5	N	300	30	N
5	ALD0140R	N	N	5	<10	<5	<20	N	N	7	20	N	<5	N	N	15	N
6	ALD0142R	N	N	5	15	20	50	N	<20	10	30	N	5	N	N	30	N
7	ALD0144R	N	N	<5	70	30	30	N	<20	7	15	N	5	N	N	50	N
8	ALD0524R	N	N	7	100	<5	30	N	<20	20	15	N	10	N	N	70	N
9	ALD0525R	N	N	7	100	<5	50	N	<20	30	15	N	7	N	N	70	N
10	ALD0526R	N	N	7	100	5	100	N	<20	30	15	N	7	N	<100	100	N
11	ALD0539R	N	N	7	15	N	50	N	<20	10	15	N	<5	N	N	30	N
12	ALD0540R	N	N	10	<10	<5	N	N	N	70	N	N	5	N	N	50	N
13	ALD0541R	N	N	7	100	<5	50	N	<20	30	20	N	10	N	N	100	N
14	ALD1221R	N	N	<5	30	<5	20	N	N	5	10	N	<5	N	N	20	N
15	COG3315R	N	N	5	<10	10	<20	5	N	7	<10	N	<5	N	<100	15	<50
16	COG3316R	N	N	5	30	7	30	N	<20	10	15	N	7	N	N	30	N
17	COG3317R	N	N	5	<10	10	<20	300	N	10	20	N	5	N	N	20	N
18	COG3318R	N	N	5	20	<5	20	N	N	10	10	N	7	N	N	30	N
19	COG3321R	N	N	7	10	10	<20	15	N	5	<10	N	<5	N	<100	20	N
20	COG3322R	N	N	<5	15	15	50	N	<20	10	15	N	7	N	N	30	<50
21	COG3323R	50	N	5	15	150	30	7	<20	10	150	200	7	N	N	50	N
22	E0037A	N	N	5	30	<5	20	N	<20	10	20	N	5	N	500	30	N
23	QUI0126R	N	N	5	50	30	30	N	<20	15	30	N	5	N	N	30	N
24	QUI0127R	N	N	5	70	5	70	N	<20	20	20	N	7	N	N	50	N
25	QUI0128R	N	N	5	10	10	20	N	N	10	15	N	N	N	200	30	N
26	QUI0129R	N	N	N	70	10	20	N	<20	15	50	N	5	N	N	50	N
27	QUI0130R	15	N	N	20	7	20	N	<20	10	30	N	5	N	<100	50	N
28	QUI0143R	N	N	5	30	<5	20	N	<20	10	20	N	5	N	N	50	N
29	QUI0513R	N	N	<5	<10	100	<20	15	N	10	20	N	N	N	N	<10	N
30	QUI0515R	N	N	<5	<10	50	<20	10	N	10	10	N	<5	N	<100	<10	N
31	QUI0519R	N	N	7	70	<5	20	N	<20	20	15	N	7	N	<100	50	N
32	QUI0520R	N	N	N	<10	<5	<20	N	N	<5	15	N	<5	N	N	10	N
33	QUI1217R	N	N	10	70	<5	50	N	<20	50	15	N	10	N	N	70	N
34	QUI1218R	N	N	7	100	5	30	N	<20	30	15	N	7	N	<100	50	N
35	QUI1219R	N	N	7	50	5	30	5	<20	15	10	N	7	N	N	50	N
36	QUI1220R	N	N	5	20	<5	30	N	<20	15	10	N	7	N	N	50	N
37	QUI1822R	N	N	7	100	<5	30	N	<20	20	20	N	7	N	N	50	N
38	QUI1825R	N	N	N	15	N	30	N	N	<5	10	N	5	N	N	30	N
39	QUI1827R	20	N	30	10	5	<20	10	N	15	20	N	<5	N	1,000	20	N
40	S0042A	N	N	N	20	<5	20	N	N	5	<10	N	5	N	N	20	N
41	S0043A	N	N	N	20	10	30	N	N	5	10	N	<5	N	N	20	N
42	S0044A	30	N	15	15	150	20	N	N	15	100	100	N	N	N	20	N
43	S0074A	15	N	<5	15	70	20	70	N	10	30	<100	5	N	300	70	<50
44	S0075A	N	N	<5	15	20	20	10	N	10	30	N	<5	N	N	30	N
45	S0079A	N	N	<5	20	15	<20	N	N	5	30	<100	<5	N	N	20	<50
46	S0080A	N	N	N	15	10	<20	N	N	5	15	100	<5	N	N	10	N
47	S0081A	N	N	5	50	10	30	N	N	7	30	N	5	N	300	50	N

TABLE1. ROCK SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1 x2 CUSMAP QUADRANGLE,MONTANA(continued)

MAP #	SAMPLE	S-Y	S-ZN	S-ZR	S-TH	AA-AU	AA-CU	AA-PB	AA-ZN	AA-AG	AA-CD	AA-BI	AA-SB
1	80635	<10	N	150	N	<.05	5	1	1	<.05	.05	<1.0	<1
2	ALD0137R	<10	N	100	N	--	N	N	N	N	.17	N	N
3	ALD0138R	20	N	300	N	--	N	N	3	N	.20	N	N
4	ALD0139R	20	N	300	N	--	N	N	4	N	.24	N	N
5	ALD0140R	N	N	150	N	--	N	N	N	N	.16	N	N
6	ALD0142R	15	N	300	N	--	4	1	3	<.05	.25	N	N
7	ALD0144R	20	N	700	N	--	N	N	4	N	.23	N	N
8	ALD0524R	30	N	500	N	--	13	21	7	2.70	1.22	N	7
9	ALD0525R	30	N	700	N	--	8	13	5	1.90	1.05	N	5
10	ALD0526R	30	N	700	N	--	6	10	4	1.50	.84	N	4
11	ALD0539R	15	N	70	N	--	3	3	N	.70	.67	N	2
12	ALD0540R	20	N	20	N	--	4	4	12	.60	.87	N	3
13	ALD0541R	30	N	700	N	--	2	16	9	.67	.86	N	2
14	ALD1221R	15	N	200	--	--	N	2	1	N	.28	N	N
15	COG3315R	N	N	N	N	--	5	4	19	.39	N	1.0	3
16	COG3316R	20	N	300	N	--	2	4	10	.38	N	1.0	3
17	COG3317R	30	N	N	N	--	3	7	7	.09	N	2.0	2
18	COG3318R	20	N	150	N	--	N	2	2	<.05	N	1.0	3
19	COG3321R	<10	N	20	N	--	7	5	6	.26	N	2.0	10
20	COG3322R	15	N	100	N	--	19	6	5	.07	N	1.0	14
21	COG3323R	20	N	70	N	--	150	148	34	3.15	N	38.0	94
22	E0037A	15	N	70	N	<.05	--	--	--	--	--	--	--
23	QUI0126R	10	N	700	N	--	10	1	1	<.05	.16	N	N
24	QUI0127R	30	N	700	N	--	N	1	10	N	.28	N	N
25	QUI0128R	15	N	500	N	--	N	N	1	N	.12	N	N
26	QUI0129R	20	N	300	N	--	N	N	6	.52	.21	3.0	N
27	QUI0130R	15	N	150	N	--	N	N	N	1.68	.11	N	N
28	QUI0143R	10	N	200	N	--	N	1	1	N	.18	1.0	N
29	QUI0513R	10	N	N	N	--	470	960	160	80.00	70.00	N	350
30	QUI0515R	N	N	30	N	--	100	96	10	7.80	7.24	2.0	31
31	QUI0519R	10	N	150	N	--	27	42	7	5.30	2.64	N	16
32	QUI0520R	20	N	30	N	--	19	26	7	3.60	1.75	N	10
33	QUI1217R	30	N	300	--	--	N	2	1	N	.27	N	N
34	QUI1218R	30	N	300	--	--	N	3	4	N	.35	N	N
35	QUI1219R	15	N	200	--	--	N	3	2	<.05	.34	N	N
36	QUI1220R	20	N	300	--	--	N	2	8	N	.41	N	N
37	QUI1822R	50	N	700	N	--	N	N	1	<.05	.09	N	N
38.	QUI1825R	10	N	50	N	--	N	N	1	.11	.08	N	N
39	QUI1827R	<10	N	N	N	--	1	8	N	1.84	.12	8.0	1
40	S0042A	15	N	150	N	.12	--	--	--	--	--	--	--
41	S0043A	15	N	150	N	<.05	--	--	--	--	--	--	--
42	S0044A	20	N	100	N	.75	--	--	--	--	--	--	--
43	S0074A	10	N	20	N	1.80	--	--	--	--	--	--	--
44	S0075A	15	N	50	N	1.90	--	--	--	--	--	--	--
45	S0079A	10	N	150	N	.60	--	--	--	--	--	--	--
46	S0080A	20	N	150	N	.40	--	--	--	--	--	--	--
47	S0081A	<10	N	100	N	<.05	--	--	--	--	--	--	--

TABLE 1. ROCK SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1° x2° CUSMAP QUADRANGLE, MONTANA (continued)

MAP #	SAMPLE	S-Y	S-ZN	S-ZR	S-TH	AA-AU	AA-CU	AA-PB	AA-ZN	AA-AG	AA-CD	AA-BI	AA-SB
1	80635	<10	N	150	N	<.05	5	1	1	<.05	.05	<1.0	<1
2	ALD0137R	<10	N	100	N	--	N	N	N	N	.17	N	N
3	ALD0138R	20	N	300	N	--	N	N	3	N	.20	N	N
4	ALD0139R	20	N	300	N	--	N	N	4	N	.24	N	N
5	ALD0140R	N	N	150	N	--	N	N	N	N	.16	N	N
6	ALD0142R	15	N	300	N	--	4	1	3	<.05	.25	N	N
7	ALD0144R	20	N	700	N	--	N	N	4	N	.23	N	N
8	ALD0524R	30	N	500	N	--	13	21	7	2.70	1.22	N	7
9	ALD0525R	30	N	700	N	--	8	13	5	1.90	1.05	N	5
10	ALD0526R	30	N	700	N	--	6	10	4	1.50	.84	N	4
11	ALD0539R	15	N	70	N	--	3	3	N	.70	.67	N	2
12	ALD0540R	20	N	20	N	--	4	4	12	.60	.87	N	3
13	ALD0541R	30	N	700	N	--	2	16	9	.67	.86	N	2
14	ALD1221R	15	N	200	--	--	N	2	1	N	.28	N	N
15	COG3315R	N	N	N	N	--	5	4	19	.39	N	1.0	3
16	COG3316R	20	N	300	N	--	2	4	10	.38	N	1.0	3
17	COG3317R	30	N	N	N	--	3	7	7	.09	N	2.0	2
18	COG3318R	20	N	150	N	--	N	2	2	<.05	N	1.0	3
19	COG3321R	<10	N	20	N	--	7	5	6	.26	N	2.0	10
20	COG3322R	15	N	100	N	--	19	6	5	.07	N	1.0	14
21	COG3323R	20	N	70	N	--	150	148	34	3.15	N	38.0	94
22	E0037A	15	N	70	N	<.05	--	--	--	--	--	--	--
23	QUI0126R	10	N	700	N	--	10	1	1	<.05	.16	N	N
24	QUI0127R	30	N	700	N	--	N	1	10	N	.28	N	N
25	QUI0128R	15	N	500	N	--	N	N	1	N	.12	N	N
26	QUI0129R	20	N	300	N	--	N	N	6	.52	.21	3.0	N
27	QUI0130R	15	N	150	N	--	N	N	N	1.68	.11	N	N
28	QUI0143R	10	N	200	N	--	N	1	1	N	.18	1.0	N
29	QUI0513R	10	N	N	N	--	470	960	160	80.00	70.00	N	350
30	QUI0515R	N	N	30	N	--	100	96	10	7.80	7.24	2.0	31
31	QUI0519R	10	N	150	N	--	27	42	7	5.30	2.64	N	16
32	QUI0520R	20	N	30	N	--	19	26	7	3.60	1.75	N	10
33	QUI1217R	30	N	300	--	--	N	2	1	N	.27	N	N
34	QUI1218R	30	N	300	--	--	N	3	4	N	.35	N	N
35	QUI1219R	15	N	200	--	--	N	3	2	<.05	.34	N	N
36	QUI1220R	20	N	300	--	--	N	2	8	N	.41	N	N
37	QUI1822R	50	N	700	N	--	N	N	1	<.05	.09	N	N
38	QUI1825R	10	N	50	N	--	N	N	1	.11	.08	N	N
39	QUI1827R	<10	N	N	N	--	1	8	N	1.84	.12	8.0	1
40	S0042A	15	N	150	N	.12	--	--	--	--	--	--	--
41	S0043A	15	N	150	N	<.05	--	--	--	--	--	--	--
42	S0044A	20	N	100	N	.75	--	--	--	--	--	--	--
43	S0074A	10	N	20	N	1.80	--	--	--	--	--	--	--
44	S0075A	15	N	50	N	1.90	--	--	--	--	--	--	--
45	S0079A	10	N	150	N	.60	--	--	--	--	--	--	--
46	S0080A	20	N	150	N	.40	--	--	--	--	--	--	--
47	S0081A	<10	N	100	N	<.05	--	--	--	--	--	--	--

TABLE 1. ROCK SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1° x2° CUSMAP QUADRANGLE, MONTANA (continued)

MAP #	SAMPLE	LATITUDE	LONGITUDE	S-FE%	S-MG%	S-CA%	S-TI%	S-MN	S-AG	S-AS	S-AU	S-B	S-BA	S-BE
48	STC0145R	46 22 15	113 37 44	1.50	.30	.10	.100	300	N	N	N	200	300	3.0
49	STC0146R	46 22 4	113 37 44	3.00	7.00	15.00	.200	700	N	N	N	<10	100	N
50	STC3243R	46 18 23	113 39 38	1.00	<.02	<.05	<.002	10	30.0	N	10	<10	>5,000	<1.0
51	STC3244R	46 18 23	113 39 38	2.00	.15	.05	.500	70	1.0	N	N	<10	300	1.0
52	STC3245R	46 18 23	113 39 38	.70	.10	.07	.150	30	<.5	N	N	<10	500	1.0
53	STC3246R	46 18 23	113 39 34	1.00	<.02	<.05	.002	15	50.0	N	10	N	>5,000	1.0
54	STC3247R	46 18 23	113 39 34	1.50	.15	.05	.200	50	.5	N	N	<10	500	2.0
55	STC3248R	46 18 23	113 39 34	1.00	.15	.07	.150	30	N	N	N	<10	700	1.5
56	STC3251R	46 18 36	113 39 58	.50	<.02	<.05	.015	20	3.0	N	N	N	2,000	N
[illegible]	STC3252R	46 18 36	113 39 58	5.00	.05	N	.150	70	5.0	N	N	N	700	<1.0
	STC3253R	46 18 36	113 39 58	.70	.20	.15	.150	50	N	N	N	<10	500	2.0

TABLE1. ROCK SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1° x2°CUSMAP QUADRANGLE,MONTANA(continued)

MAP#	SAMPLE	S-BI	S-CD	S-CO	S-CR	S-CU	S-LA	S-MO	S-NB	S-NI	S-PB	S-SB	S-SC	S-SN	S-SR	S-V	S-W
48	STC0145R	N	N	N	<10	10	20	N	<20	7	10	N	5	N	N	10	N
49	STC0146R	N	N	N	50	<5	<20	N	<20	30	10	N	7	N	N	50	N
50	STC3243R	70	N	10	<10	500	<20	N	N	20	150	150	N	N	300	N	N
51	STC3244R	N	N	5	30	20	70	N	<20	15	20	N	<5	N	N	50	N
52	STC3245R	N	N	N	10	<5	20	N	<20	<5	15	N	<5	N	N	15	N
53	STC3246R	30	N	<5	<10	150	<20	10	N	5	200	200	<5	N	300	<10	N
54	STC3247R	N	N	N	20	7	30	N	<20	7	15	N	5	N	N	50	N
55	STC3248R	N	N	N	10	5	<20	N	<20	5	15	N	5	N	N	20	N
56	STC3251R	N	N	N	<10	10	<20	N	<20	<5	30	N	N	N	N	<10	N
57	STC3252R	N	N	5	20	30	<20	70	<20	10	30	N	5	N	N	30	N
58	STC3253R	N	N	<5	15	15	20	N	<20	5	20	N	5	N	N	70	N

TABLE 1. ROCK SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1°x2° CUSMAP QUADRANGLE, MONTANA (continued)

MAP #	SAMPLE	S-Y	S-ZN	S-ZR	S-TH	AA-AU	AA-CU	AA-PB	AA-ZN	AA-AG	AA-CD	AA-BI	AA-SB
48	STC0145R	20	N	150	N	--	N	1	1	N	.70	N	N
49	STC0146R	20	N	200	N	--	N	16	11	<.05	.57	N	1
50	STC3243R	N	N	10	N	8.70	63	120	1	27.10	.16	32.0	3
51	STC3244R	200	N	300	N	--	11	6	5	.10	.05	N	1
52	STC3245R	15	N	200	N	--	1	2	1	<.05	N	N	N
53	STC3246R	N	N	10	N	14.80	1	N	1	.80	.18	1.0	2
54	STC3247R	15	N	200	N	--	4	4	4	.33	.06	N	1
55	STC3248R	15	N	100	N	--	1	2	2	.05	<.05	N	N
56	STC3251R	<10	N	50	N	--	5	14	1	.94	N	N	N
57	STC3252R	20	N	300	N	--	14	8	8	2.04	N	2.0	2
58	STC3253R	20	N	150	N	--	11	1	1	.06	N	N	1

TABLE 2.PAN-CONCENTRATE SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1°x2° CUSMAP QUADRANGLE, MONTANA(continued)

MAP#	SAMPLE	LATITUDE	LONGITUDE	S-FE%	S-MG%	S-CA%	S-TI%	S-MN	S-AG	S-AS	S-AU	S-B	S-BA	S-BE
59	QUI1823P	46 26 10	113 41 50	7.00	1.00	.15	.700	300	N	N	N	300	2,000	3.0
60	QUI2730P	46 26 8	113 44 47	1.50	.50	.10	.300	150	<1.0	N	N	50	700	3.0
61	QUI2732P	46 25 54	113 44 24	1.00	.30	.30	.200	150	N	N	N	50	700	3.0
62	QUI2735P	46 25 19	113 42 49	2.00	.30	.10	.700	150	N	N	N	150	1,000	2.0
63	QUI2737P	46 24 44	113 42 17	2.00	.30	<.10	.500	150	N	N	N	100	2,000	3.0
64	QUI2739P	46 24 35	113 41 55	2.00	.70	<.10	.500	100	N	N	N	150	700	2.0
65	QUI2741P	46 24 4	113 42 0	3.00	.30	.15	.700	150	N	N	N	150	1,000	2.0
66	QUI2757P	46 24 46	113 42 41	15.00	.15	1.00	1.500	2,000	N	N	N	30	700	2.0
67	QUI2759P	46 24 24	113 42 14	15.00	.10	.70	>2.000	3,000	N	N	N	50	300	2.0
68	QUI2761P	46 23 47	113 41 20	15.00	.70	1.50	>2.000	3,000	N	N	N	50	300	N
69	QUI2763P	46 22 43	113 40 20	2.00	.50	.10	1.000	300	N	N	N	150	500	2.0
70	QUI2765P	46 22 55	113 40 13	1.50	.50	.15	.500	50	N	N	N	50	500	2.0
71	QUI3200P	46 22 52	113 38 59	1.50	.30	.15	.500	20	<1.0	N	N	100	>10,000	3.0
72	QUI3202P	46 22 35	113 38 35	1.50	1.00	.15	.500	300	N	N	N	150	1,000	5.0
73	QUI4242P	46 22 47	113 43 17	.30	.20	1.00	1.000	500	N	N	N	N	200	3.0
74	QUI4242P	46 22 47	113 43 17	.30	.15	<.05	.100	20	N	N	N	100	500	1.0
75	QUI4244P	46 23 29	113 42 21	2.00	.30	5.00	2.000	1,000	N	N	N	<20	500	3.0
76	QUI4244P	46 23 29	113 42 21	.15	.02	.50	.020	100	N	N	N	<10	300	1.5
77	QUI514P	46 26 24	113 39 24	7.00	.70	.15	.700	300	N	N	N	150	1,000	2.0
78	QUI522P	46 24 38	113 41 52	3.00	.50	.10	.700	100	N	N	N	100	500	<2.0
79	S0039P	46 18 58	113 36 13	1.00	.30	.15	.300	1,000	1.5	N	N	300	500	5.0
80	S0041P	46 19 10	113 34 36	1.00	.20	1.00	.200	1,000	N	N	N	30	1,000	5.0
81	S0046P	46 20 17	113 32 56	2.00	.20	1.50	.150	700	N	N	N	20	2,000	3.0
82	S0048P	46 20 16	113 33 7	3.00	.30	.70	.200	500	N	N	N	<20	3,000	3.0
83	STC2768P	46 21 44	113 38 13	1.50	.50	.15	.200	200	N	N	N	50	5,000	3.0
84	STC2770P	46 21 23	113 38 12	1.50	1.50	2.00	.300	300	N	N	N	50	500	2.0
85	STC2772P	46 21 23	113 38 12	5.00	.70	.70	.700	700	N	N	N	70	5,000	<2.0
86	STC3249P	46 18 30	113 40 1	2.00	.50	.15	.700	300	N	N	N	70	>10,000	2.0
87	STC3254P	46 18 48	113 40 9	2.00	.30	.15	.700	200	N	N	N	150	1,000	2.0
88	STC3256P	46 19 19	113 39 59	1.50	.30	<.10	.700	50	N	N	N	100	700	<2.0
89	STC3295P	46 19 33	113 39 8	3.00	.50	5.00	7.000	200	N	N	N	500	7,000	<2.0
90	STC3295P	46 19 33	113 39 8	.50	.20	.50	.100	200	N	N	N	20	300	1.5
91	STC3297P	46 19 14	113 38 8	5.00	.30	7.00	.700	300	70.0	N	70	70	>10,000	100.0
92	STC3297P	46 19 14	113 38 8	.70	.20	.70	.150	100	2.0	N	N	30	300	1.0
	STC3299P	46 19 11	113 38 6	3.00	.15	2.00	1.500	300	N	N	N	700	>10,000	5.0
94	STC3299P	46 19 11	113 38 6	.70	.15	.30	.150	150	<.5	N	N	50	300	1.0
95	STC4222P	46 20 33	113 39 47	15.00	1.00	.50	>2.000	500	N	N	N	700	10,000	N
96	STC4222P	46 20 33	113 39 47	2.00	1.00	.50	.200	200	N	N	N	50	500	1.0
97	STC4224P	46 20 25	113 39 56	5.00	1.50	1.50	>2.000	200	N	N	N	1,500	500	2.0
98	STC4224P	46 20 25	113 39 56	.50	.15	<.05	.050	70	<.5	N	N	20	200	<1.0
99	STC4226P	46 19 30	113 41 18	7.00	2.00	2.00	>2.000	500	N	N	N	1,000	3,000	<2.0
100	STC4226P	46 19 30	113 41 18	.70	.30	.05	.100	50	N	N	N	70	300	<1.0
101	STC4228P	46 18 23	113 43 4	7.00	1.00	.30	2.000	100	N	N	N	500	1,000	3.0
102	STC4228P	46 18 23	113 43 4	.70	.30	<.05	.150	70	N	N	N	70	200	1.0
103	STC4274P	46 20 58	113 42 27	10.00	.30	.30	>2.000	700	N	N	N	1,500	1,500	N
104	STC4274P	46 20 58	113 42 27	.20	.15	<.05	.070	15	N	N	N	20	150	<1.0

TABLE 2.PAN-CONCENTRATE SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1°x2° CUSMAP QUADRANGLE, MONTANA(continued)

MAP #	SAMPLE	S-BI	S-CD	S-CO	S-CR	S-CU	S-LA	S-MO	S-NB	S-NI	S-PB	S-SB	S-SC	S-SN	S-SR	S-V
59	QUI1823P	N	N	<10	100	<10	70	N	<50	20	<20	N	15	N	<200	150
60	QUI2730P	N	N	<10	50	<10	50	N	<50	<10	20	N	10	N	N	50
61	QUI2732P	N	N	N	20	<10	50	N	N	<10	20	N	10	N	N	30
62	QUI2735P	N	N	N	50	<10	70	N	<50	N	20	N	10	N	N	70
63	QUI2737P	N	N	<10	30	<10	50	N	<50	<10	20	N	10	N	N	70
64	QUI2739P	N	N	<10	50	<10	50	N	<50	10	20	N	10	N	N	50
65	QUI2741P	N	N	<10	100	<10	70	N	<50	N	30	N	10	N	N	50
66	QUI2757P	N	N	<10	50	<10	150	N	100	<10	30	N	20	N	<200	150
67	QUI2759P	N	N	10	50	10	1,500	N	200	N	70	N	20	150	N	300
68	QUI2761P	N	N	20	150	30	300	N	150	15	30	N	20	N	N	200
69	QUI2763P	N	N	<10	30	<10	<50	N	<50	10	<20	N	<10	N	N	50
70	QUI2765P	N	N	N	50	<10	50	N	N	<10	<20	N	<10	N	N	50
71	QUI3200P	N	N	<10	20	<10	50	N	<50	10	<20	N	10	N	N	50
72	QUI3202P	N	N	<10	20	<10	50	N	<50	20	20	N	10	N	N	70
73	QUI4242P	N	N	N	70	30	>2,000	N	<50	10	70	N	<10	N	N	50
74	QUI4242P	N	N	N	15	<5	20	N	N	<5	10	N	5	N	N	15
75	QUI4244P	1,000	N	N	100	15	>2,000	N	70	10	150	N	<10	<20	N	70
76	QUI4244P	N	N	N	<10	N	20	N	N	<5	20	N	N	N	100	<10
77	QUI514P	N	N	10	100	10	10	N	<50	20	20	N	15	N	N	70
78	QUI522P	N	N	<10	70	<10	50	N	<50	10	20	N	10	N	N	70
79	S0039P	N	N	N	100	<10	50	N	N	15	20	N	<10	N	<200	30
80	S0041P	N	N	<10	70	<10	<50	N	N	15	50	N	N	N	500	30
81	S0046P	N	N	<10	30	<10	50	N	N	10	20	N	N	N	N	50
82	S0048P	N	N	<10	30	<10	<50	N	N	10	<20	N	N	N	500	200
83	STC2768P	N	N	N	20	<10	50	N	N	10	<20	N	<10	N	N	50
84	STC2770P	N	N	N	20	<10	50	N	N	10	<20	N	10	N	N	30
85	STC2772P	N	N	15	50	10	50	N	N	<10	<20	N	10	N	N	70
86	STC3249P	N	N	<10	50	10	100	N	<50	10	20	N	10	N	N	70
87	STC3254P	N	N	<10	100	10	50	N	<50	10	50	N	10	N	N	70
88	STC3256P	N	N	<10	50	<10	70	N	<50	<10	<20	N	10	N	N	70
89	STC3295P	N	N	<10	<20	100	>2,000	N	<50	<10	200	N	N	N	N	200
90	STC3295P	N	N	<5	15	<5	20	N	N	5	20	N	<5	N	500	15
91	STC3297P	N	N	20	30	50	1,500	N	N	50	100	N	N	N	1,000	50
92	STC3297P	N	N	5	<10	7	<20	N	N	7	30	N	<5	N	300	20
93	STC3299P	N	N	<10	20	15	300	N	<50	10	70	N	N	N	2,000	30
94	STC3299P	N	N	5	15	5	<20	N	N	10	20	N	5	N	150	15
95	STC4222P	N	N	15	300	20	700	N	100	70	70	<200	N	N	<200	200
96	STC4222P	N	N	10	100	20	20	N	N	50	10	N	7	N	<100	70
97	STC4224P	N	N	<10	200	50	700	N	<50	N	150	N	N	N	N	150
98	STC4224P	N	N	N	15	<5	N	N	N	5	10	N	N	N	N	10
99	STC4226P	N	N	10	200	150	700	N	50	20	150	<200	N	30	N	100
100	STC4226P	N	N	N	30	<5	<20	N	N	7	10	N	<5	N	N	20
101	STC4228P	N	N	10	70	<10	100	10	<50	50	150	N	N	N	N	100
102	STC4228P	N	N	N	20	<5	<20	N	N	5	10	N	<5	N	N	20
103	STC4274P	N	N	<10	150	10	150	N	70	10	50	N	N	N	N	100
104	STC4274P	N	N	N	15	<5	20	N	N	7	<10	N	N	N	N	10

TABLE 2.PAN-CONCENTRATE SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1°x2° CUSMAP QUADRANGLE, MONTANA(continued)

MAP #	SAMPLE	S-W	S-Y	S-ZN	S-ZR	S-TH	AA-AU
59	QUI1823P	N	50	N	500	N	.16
60	QUI2730P	N	<20	N	500	N	<.05
61	QUI2732P	N	20	N	200	N	3.62
62	QUI2735P	N	30	N	1,500	N	<.05
63	QUI2737P	N	70	N	1,500	N	<.05
64	QUI2739P	N	20	N	700	N	<.05
65	QUI2741P	N	30	N	>2,000	N	<.05
66	QUI2757P	N	70	N	200	N	<.05
67	QUI2759P	100	300	N	1,000	<200	3.60
68	QUI2761P	N	150	N	300	N	.89
69	QUI2763P	N	50	N	700	N	.05
70	QUI2765P	N	500	N	700	N	.23
71	QUI3200P	N	70	N	700	N	<.05
72	QUI3202P	N	70	N	500	N	<.05
73	QUI4242P	<100	1,500	N	>2,000	>5,000	.06
74	QUI4242P	N	10	N	200	N	--
75	QUI4244P	500	1,500	N	>2,000	5,000	.07
76	QUI4244P	N	N	N	30	N	--
77	QUI514P	N	50	N	700	N	<.02
78	QUI522P	N	70	N	500	N	<.02
79	S0039P	N	<20	N	100	N	.05
80	S0041P	N	N	N	300	N	.10
81	S0046P	N	30	N	150	N	.09
82	S0048P	N	300	N	200	N	1.70
83	STC2768P	N	N	N	500	N	<.05
84	STC2770P	N	20	N	700	N	<.05
85	STC2772P	N	150	N	2,000	N	1.67
86	STC3249P	N	50	N	500	N	.07
87	STC3254P	N	20	N	1,000	N	<.05
88	STC3256P	N	300	N	1,500	N	<.05
89	STC3295P	N	700	N	>2,000	N	<.05
90	STC3295P	N	10	N	70	N	--
91	STC3297P	N	150	N	2,000	N	.22
92	STC3297P	N	10	N	100	N	--
93	STC3299P	N	150	N	>2,000	N	<.05
94	STC3299P	N	10	N	100	N	--
95	STC4222P	N	1,500	N	>2,000	N	.17
96	STC4222P	N	20	N	200	N	--
97	STC4224P	N	1,000	N	>2,000	N	.29
98	STC4224P	N	10	N	70	N	--
99	STC4226P	N	1,000	N	>2,000	<200	<.05
100	STC4226P	N	15	N	200	N	--
101	STC4228P	N	1,500	N	>2,000	N	<.05
102	STC4228P	N	15	N	150	N	--
103	STC4274P	N	500	N	>2,000	N	<.05
104	STC4274P	N	<10	N	70	N	--

TABLE 3. STREAM-SEDIMENT SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1°X2° CUSMAP QUADRANGLE, MONTANA (cont)

MAP #	SAMPLE	LATITUDE	LONGITUDE	S-FE%	S-MG%	S-CA%	S-TI%	S-MN	S-AG	S-AS	S-AU	S-B	S-BA	S-BE	S-BI
105	ALD0536S	46 26 23	113 36 9	3.00	.50	.50	.20	500	N	N	N	150	700	7.0	N
106	ALD0538S	46 25 51	113 36 58	3.00	.50	.30	.30	500	N	N	N	150	700	7.0	N
107	ALD1223S	46 24 6	113 36 13	2.00	.50	.70	.15	500	N	N	N	100	500	7.0	N
108	ALD1225S	46 24 5	113 36 9	3.00	.70	.70	.20	1,000	N	N	N	200	1,000	7.0	N
109	ALD2386S	46 22 45	113 32 35	3.00	1.00	1.50	.20	3,000	N	N	N	100	1,500	5.0	N
110	ALD2394S	46 25 18	113 32 20	3.00	1.50	3.00	.30	1,000	N	N	N	50	1,000	2.0	N
111	ALD2396S	46 24 43	113 32 40	7.00	1.50	3.00	.30	1,500	N	N	N	70	1,000	2.0	N
112	ALD2398S	46 24 47	113 33 35	5.00	1.50	2.00	.30	1,000	N	N	N	70	1,000	2.0	N
113	ALD2775S	46 24 11	113 32 40	10.00	1.50	3.00	.30	1,000	N	N	N	70	500	1.5	N
114	ALD4207S	46 25 56	113 33 6	3.00	1.50	2.00	.30	700	N	N	N	15	700	1.0	N
115	ALD4209S	46 25 59	113 33 4	3.00	1.50	1.50	.30	500	N	N	N	15	500	1.0	N
116	ALD4215S	46 23 46	113 34 59	3.00	.70	1.50	.30	1,000	N	N	N	50	700	1.5	N
117	COG3269S	46 18 31	113 34 12	.70	.50	15.00	.10	500	N	N	N	70	200	2.0	N
118	COG3271S	46 19 4	113 33 53	2.00	.70	1.50	.20	700	N	N	N	150	500	3.0	N
119	COG3287S	46 19 12	113 35 1	5.00	.30	.30	.15	1,500	.5	500	N	200	500	3.0	N
120	COG3289S	46 19 10	113 36 0	1.50	.20	.20	.30	700	3.0	<200	N	150	300	1.5	N
121	COG3292S	46 20 18	113 35 48	1.50	.15	.50	.20	1,000	N	N	N	150	300	2.0	N
122	COG3302S	46 21 19	113 36 20	1.50	.15	.70	.20	700	N	N	N	150	500	3.0	N
123	COG3304S	46 20 59	113 35 57	.50	.10	.50	.15	300	N	N	N	50	700	1.5	N
124	COG3306S	46 19 51	113 34 44	.70	.15	.50	.15	500	N	N	N	70	700	3.0	N
125	COG3308S	46 20 23	113 35 8	1.50	.20	.50	.20	500	N	N	N	70	300	15.0	N
126	COG3311S	46 20 56	113 36 21	1.50	.50	.30	.20	200	N	N	N	70	500	2.0	N
127	COG3320S	46 19 55	113 32 12	2.00	1.00	1.50	.20	700	N	N	N	70	300	1.0	N
128	COG3325S	46 21 0	113 32 54	1.50	.50	.70	.20	500	N	N	N	70	500	3.0	N
129	COG3329S	46 19 33	113 32 23	1.50	.70	2.00	.20	700	N	N	N	100	300	1.5	N
130	COG3331S	46 18 14	113 32 10	.70	.30	1.00	1.50	150	N	N	N	100	300	1.0	N
131	COG4217S	46 21 21	113 34 15	1.00	.15	.30	.15	700	N	N	N	100	300	1.0	N
132	COG4219S	46 20 0	113 36 31	3.00	.15	.50	.15	>5,000	N	700	N	100	700	7.0	N
133	COG4221S	46 19 4	113 36 36	2.00	.20	.50	.15	1,500	<.5	N	N	200	300	5.0	N
134	QUI0516S	46 25 37	113 39 23	2.00	.30	.50	.30	300	N	N	N	70	700	7.0	N
135	QUI0517S	46 25 36	113 39 20	3.00	.50	.50	.20	700	N	N	N	100	1,000	7.0	N
136	QUI0518S	46 25 32	113 39 33	5.00	.70	.70	.30	700	N	N	N	100	1,500	10.0	N
137	QUI0521S	46 25 2	113 40 59	3.00	.70	.70	.30	500	N	N	N	100	1,500	10.0	N
138	QUI0523S	46 24 39	113 41 50	3.00	.70	.70	.20	300	N	N	N	100	1,500	7.0	N
139	QUI0555S	46 26 27	113 39 22	3.00	.50	.50	.20	700	N	N	N	100	1,500	7.0	N
140	QUI0556S	46 26 29	113 39 25	3.00	.50	.50	.20	700	N	N	N	100	2,000	7.0	N
141	QUI1216S	46 26 26	113 37 32	3.00	.50	.70	.20	1,000	N	N	N	70	2,000	7.0	N
142	QUI1824S	46 26 10	113 41 50	3.00	.70	.70	.30	1,000	N	N	N	150	2,000	2.0	N
143	QUI1826S	46 25 32	113 42 7	2.00	.50	.70	.20	700	<.5	N	N	100	2,000	5.0	N
144	QUI2399S	46 23 23	113 39 22	1.00	.50	.70	.15	100	N	N	N	100	1,500	2.0	N
145	QUI2731S	46 26 8	113 44 47	2.00	.70	1.00	.30	300	.7	N	N	100	1,500	5.0	N
146	QUI2733S	46 25 54	113 44 26	3.00	.70	.70	.20	500	.7	N	N	100	700	7.0	N
147	QUI2734S	46 25 56	113 43 27	1.00	.20	1.00	.20	2,000	<.5	N	N	100	1,500	5.0	N
148	QUI2736S	46 25 19	113 42 49	2.00	.50	.50	.30	500	N	N	N	150	1,500	2.0	N
149	QUI2738S	46 24 44	113 42 17	1.50	.30	.70	.30	700	<.5	N	N	150	2,000	3.0	N
150	QUI2740S	46 24 35	113 41 55	1.50	.70	.70	.20	300	<.5	N	N	200	1,000	7.0	N
151	QUI2742S	46 24 4	113 42 0	1.50	.30	.30	.30	300	1.0	N	N	150	1,500	2.0	N
152	QUI2753S	46 24 46	113 42 41	1.00	.30	1.00	.15	1,000	<.5	N	N	20	500	7.0	N

TABLE 3. STREAM-SEDIMENT SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1°X2° CUSMAP QUADRANGLE,MONTANA (cont)

MAP #	SAMPLE	S-CD	S-CO	S-CR	S-CU	S-LA	S-MO	S-NB	S-NI	S-PB	S-SB	S-SC	S-SN	S-SR	S-V	S-W	S-Y	S-ZN
105	ALD0536S	N	7	50	20	50	N	<20	30	20	N	10	N	<100	50	N	70	N
106	ALD0538S	N	7	70	15	50	N	N	30	20	N	10	N	<100	50	N	30	N
107	ALD1225S	N	7	50	20	30	N	<20	20	30	N	10	N	<100	70	N	70	N
108	ALD1607S	N	7	30	20	30	N	<20	20	30	N	7	N	N	30	N	50	N
109	ALD2386S	N	10	70	20	30	N	<20	20	20	N	7	N	300	100	N	30	N
110	ALD2394S	N	10	30	15	30	N	<20	30	20	N	10	N	500	70	N	30	N
111	ALD2396S	N	15	150	15	30	N	<20	50	30	N	10	N	500	150	N	30	N
112	ALD2398S	N	10	70	15	30	N	<20	30	20	N	10	N	500	100	N	30	N
113	ALD2775S	N	20	300	20	50	N	<20	50	30	N	30	N	500	500	N	50	N
114	ALD4207S	N	15	100	20	20	N	N	30	20	N	10	N	300	100	N	15	N
115	ALD4209S	N	10	20	7	30	N	N	15	20	N	10	N	300	50	N	30	N
116	ALD4215S	N	10	50	10	30	N	<20	20	20	N	10	N	200	50	N	30	N
117	COG3269S	N	N	20	15	30	N	N	7	30	N	<5	N	300	20	N	20	N
118	COG3271S	N	10	20	15	30	N	<20	30	30	N	7	N	300	30	N	20	N
119	COG3287S	N	50	20	15	20	N	N	70	30	<100	7	N	100	30	N	30	<200
120	COG3289S	N	7	15	7	30	N	<20	15	150	N	5	N	<100	30	N	20	N
121	COG3292S	N	7	15	15	30	N	N	15	20	N	7	N	<100	30	N	70	N
122	COG3302S	N	7	20	15	20	N	N	10	30	N	5	N	300	30	N	10	N
123	COG3304S	N	<5	10	15	20	N	N	5	30	N	<5	N	N	30	N	15	N
124	COG3306S	N	7	30	20	30	N	N	7	30	N	<5	N	<100	30	N	10	N
125	COG3308S	N	7	15	15	20	N	N	15	20	N	5	N	<100	30	N	15	N
126	COG3311S	N	5	20	10	30	N	<20	15	30	N	7	N	100	30	N	20	N
127	COG3320S	N	10	50	7	30	N	<20	20	20	N	10	N	200	50	N	15	N
128	COG3325S	N	7	30	20	30	N	N	10	30	N	7	N	<100	50	N	20	N
129	COG3329S	N	7	15	15	20	N	N	10	20	N	7	N	N	30	N	15	N
130	COG3331S	N	5	15	10	30	N	N	7	20	N	5	N	N	30	N	15	N
131	COG4217S	N	5	<10	7	20	N	N	10	20	N	<5	N	<100	20	N	20	N
132	COG4219S	N	70	20	15	20	N	N	150	20	N	5	N	100	30	N	30	<200
133	COG4221S	N	7	15	20	20	N	N	20	30	N	5	N	200	30	N	15	<200
134	QUI0516S	N	7	50	20	30	N	N	20	15	N	10	N	<100	50	N	70	N
135	QUI0517S	N	10	50	30	50	N	N	30	20	N	10	N	<100	70	N	70	N
136	QUI0518S	N	15	70	30	50	N	N	50	20	N	20	N	<100	70	N	100	N
137	QUI0521S	N	10	50	30	50	N	<20	50	20	N	15	N	<100	50	N	70	N
138	QUI0523S	N	7	50	20	30	N	<20	50	15	N	15	N	<100	50	N	70	N
139	QUI0555S	N	10	50	20	30	N	<20	50	20	N	15	N	<100	50	N	70	N
140	QUI0556S	N	10	50	30	30	N	N	30	20	N	15	N	100	70	N	70	N
141	QUI1236S	N	7	50	20	30	N	N	30	20	N	10	N	100	50	N	100	500
142	QUI1824S	N	7	50	20	50	N	<20	20	30	N	15	N	<100	70	N	70	N
143	QUI1826S	N	<5	30	20	30	N	<20	15	20	N	10	N	<100	70	N	70	N
144	QUI2399S	N	5	10	10	50	N	<20	10	20	N	5	N	N	30	N	30	N
145	QUI2731S	N	7	70	20	30	N	<20	15	30	N	7	N	<100	50	N	50	N
146	QUI2733S	N	7	100	15	30	N	<20	15	30	N	7	N	<100	50	N	20	N
147	QUI2734S	N	5	50	30	30	N	N	10	50	N	7	N	<100	50	N	20	N
148	QUI2736S	N	7	50	15	50	N	<20	15	30	N	7	N	N	50	N	30	N
149	QUI2738S	N	5	70	15	50	N	N	10	30	N	7	N	<100	30	N	30	N
150	QUI2740S	N	7	70	15	30	N	<20	20	30	N	7	N	<100	30	N	30	N
151	QUI2742S	N	5	100	15	30	N	<20	10	30	N	7	N	<100	30	N	30	N
152	QUI2758S	N	<5	15	7	30	N	<20	5	30	N	5	N	200	30	N	20	N

TABLE 3. STREAM-SEDIMENT SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1°X2° CUSMAP QUADRANGLE,MONTANA (cont.)

MAP #	SAMPLE	S-ZR	S-TH	AA-CU	AA-PB	AA-ZN	AA-AG	AA-CD	AA-BI	AA-SB
105	ALD0536S	500	N	.80	.7	.7	<.02	.03	<.5	<1.0
106	ALD0538S	300	N	.40	<.5	1.1	<.02	.04	<.5	<1.0
107	ALD1223S	150	N	.80	1.0	.9	<.02	.04	<.5	<1.0
108	ALD1225S	200	N	.60	.8	<.5	<.02	<.02	<.5	<1.0
109	ALD2386S	300	N	2.00	2.0	4.0	<.05	.05	N	N
110	ALD2394S	300	N	3.00	3.0	6.0	<.05	.05	N	N
111	ALD2396S	700	N	4.00	3.0	10.0	<.05	.09	1.0	N
112	ALD2398S	500	N	5.00	5.0	10.0	<.05	.19	N	N
113	ALD2775S	700	N	5.00	6.0	5.0	<.05	.16	N	1.0
114	ALD4207S	300	N	12.00	4.0	25.0	.05	.05	N	1.0
115	ALD4209S	300	N	3.00	3.0	11.0	<.05	.05	N	N
116	ALD4215S	300	N	6.00	4.0	14.0	<.05	N	N	1.0
117	COG3269S	50	N	13.00	16.0	17.0	.12	1.02	1.0	N
118	COG3271S	150	N	12.00	8.0	32.0	.06	.63	1.0	2.0
119	COG3287S	200	N	14.00	19.0	290.0	.78	.50	N	41.0
120	COG3289S	300	N	7.00	110.0	104.0	1.40	1.40	N	18.0
121	COG3292S	200	N	N	1.0	1.0	.05	.32	3.0	8.0
122	COG3302S	200	N	18.00	14.0	78.0	.09	.60	N	3.0
123	COG3304S	100	N	30.00	31.0	2.0	.13	1.27	2.0	5.0
124	COG3306S	70	N	22.00	18.0	55.0	.10	.73	1.0	3.0
125	COG3308S	200	N	15.00	7.0	21.0	.05	.40	N	2.0
126	COG3311S	200	N	5.00	4.0	5.0	N	.05	N	N
127	COG3320S	300	N	4.00	3.0	22.0	<.05	.25	N	1.0
128	COG3325S	300	N	23.00	17.0	35.0	.09	.60	N	2.0
129	COG3329S	150	N	14.00	7.0	20.0	<.05	.34	N	1.0
130	COG3331S	150	N	11.00	6.0	12.0	.06	N	N	1.0
131	COG4217S	300	N	5.00	3.0	4.0	<.05	N	N	N
132	COG4219S	100	N	19.00	18.0	150.0	.90	.47	1.0	25.0
133	COG4221S	100	N	23.00	35.0	120.0	.87	.11	N	4.0
134	QUI0516S	200	N	2.00	.6	1.7	<.02	.04	<.5	<1.0
135	QUI0517S	200	N	2.20	1.0	1.7	<.02	.04	<.5	<1.0
136	QUI0518S	300	N	2.80	.5	.6	<.02	.03	<.5	<1.0
137	QUI0521S	200	N	.40	1.0	1.8	<.02	.04	<.5	<1.0
138	QUI0523S	300	N	.30	.5	.8	<.02	.06	<.5	<1.0
139	QUI0555S	200	N	2.00	1.0	1.3	<.02	.03	<.5	1.0
140	QUI0556S	200	N	2.10	.7	1.5	<.02	.03	<.5	<1.0
141	QUI1216S	150	N	1.60	1.3	1.0	<.02	.06	<.5	<1.0
142	QUI1824S	500	N	1.00	1.2	.7	<.02	.03	<.5	<1.0
143	QUI1826S	150	N	1.30	1.0	1.5	<.02	.03	<.5	<1.0
144	QUI2399S	300	N	5.00	3.0	4.0	.08	<.05	8.0	N
145	QUI2731S	300	N	11.00	9.0	7.0	.51	.23	1.0	N
146	QUI2733S	300	N	8.00	8.0	14.0	.39	.55	3.0	1.0
147	QUI2734S	200	N	40.00	35.0	110.0	.31	1.50	3.0	2.0
148	QUI2736S	300	N	5.00	6.0	5.0	.06	.20	N	1.0
149	QUI2738S	500	N	7.00	9.0	10.0	.06	.30	N	1.0
150	QUI2740S	200	N	5.00	4.0	4.0	<.05	.15	N	1.0
151	QUI2742S	300	N	6.00	7.0	11.0	.06	.15	N	N
152	QUI2758S	200	N	3.00	8.0	8.0	.77	.31	N	N

TABLE 3. STREAM-SEDIMENT SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1°X2° CUSMAP QUADRANGLE, MONTANA

Map #	SAMPLE	LATITUDE	LONGITUDE	S-FE%	S-MG%	S-CA%	S-TI%	S-MN	S-AG	S-AS	S-AU	S-B	S-BA	S-BE	S-BI
155	QU12760S	46 24 24	113 42 14	1.50	.30	1.50	.20	500	1.0	N	N	50	500	5.0	N
[illegible]	QU12762S	46 23 47	113 41 20	2.00	.30	1.00	1.00	1,000	N	N	N	50	500	3.0	N
[illegible]	QU12764S	46 22 45	113 40 20	2.00	.50	1.00	.20	1,500	N	N	N	200	1,500	5.0	N
[illegible]	QU12766S	46 22 55	113 40 13	1.50	.50	.50	.20	300	<.5	N	N	100	700	3.0	N
[illegible]	QU12767S	46 23 22	113 40 57	2.00	.70	.30	.30	700	<.5	N	N	70	500	3.0	N
[illegible]	QU13201S	46 22 52	113 38 59	1.00	.30	1.50	.15	500	N	N	N	100	2,000	7.0	N
[illegible]	QU13203S	46 22 35	113 38 35	3.00	1.00	1.00	.20	1,000	N	N	N	200	1,000	7.0	N
160	QU14243S	46 22 47	113 43 17	1.50	.20	.70	.20	300	N	N	N	15	500	3.0	N
[illegible]	QU14245S	46 23 29	113 42 21	1.50	.15	.70	.20	700	N	N	N	10	300	5.0	N
[illegible]	S0038S	46 18 58	113 36 13	2.00	.70	.70	.20	1,500	3.0	N	N	300	700	5.0	N
[illegible]	S0040S	46 19 10	113 34 36	2.00	.50	1.00	.30	700	N	N	N	30	1,000	2.0	N
161	S0045S	46 20 17	113 32 56	2.00	1.00	1.50	.20	1,000	N	N	N	50	700	3.0	N
[illegible]	S0047S	46 20 16	113 33 7	3.00	1.00	1.50	.30	1,500	N	N	N	70	1,000	3.0	N
166	STC2769S	46 21 44	113 38 13	3.00	.70	1.00	.20	500	<.5	N	N	70	1,000	7.0	N
167	STC2771S	46 21 23	113 38 12	3.00	1.00	2.00	.20	700	N	N	N	100	700	2.0	N
[illegible]	STC2773S	46 21 23	113 38 12	3.00	1.00	2.00	.20	700	N	N	N	100	700	3.0	N
[illegible]	STC3250S	46 18 30	113 40 1	2.00	.70	.50	.30	700	<.5	N	N	70	2,000	3.0	N
170	STC3255S	46 18 48	113 40 9	2.00	.50	.50	.30	700	.5	N	N	70	3,000	5.0	N
171	STC3257S	46 19 19	113 39 59	1.50	.50	.30	.30	200	N	N	N	100	1,000	3.0	N
[illegible]	STC3258S	46 19 49	113 39 1	1.00	.30	.50	.30	1,500	N	N	N	70	700	1.5	N
[illegible]	STC3296S	46 19 33	113 39 8	2.00	.50	.70	.20	1,500	N	N	N	30	700	3.0	N
[illegible]	STC3298S	46 19 14	113 38 8	.70	.15	.70	.15	300	N	N	N	50	500	3.0	N
[illegible]	STC3300S	46 19 11	113 38 6	.50	.10	.50	.10	300	N	N	N	70	700	3.0	N
[illegible]	STC3301S	46 19 47	113 37 40	3.00	.70	.50	.30	700	N	N	N	100	700	2.0	N
[illegible]	STC4223S	46 20 33	113 39 47	.70	.20	.30	.15	500	N	N	N	30	500	3.0	N
[illegible]	STC4225S	46 20 25	113 39 56	1.00	.15	.30	.20	700	N	N	N	30	700	3.0	N
[illegible]	STC4227S	46 19 30	113 41 18	.70	.20	.50	.15	300	N	N	N	50	1,500	3.0	N
[illegible]	STC4229S	46 18 23	113 43 4	1.50	.30	.20	.20	300	N	N	N	100	1,000	1.5	N
[illegible]	STC4275S	46 20 58	113 42 27	.70	.30	.20	.15	150	N	N	N	70	700	1.5	N

BLE 3. STREAM-SEDIMENT SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1°X2° CUSMAP QUADRANGLE, MONTANA (cont

Map #	SAMPLE	S-CD	S-CO	S-CR	S-CU	S-LA	S-MO	S-NB	S-NI	S-PB	S-SB	S-SC	S-SN	S-SR	S-V	S-W	S-Y	S-ZN
153	QUI2760S	N	<5	10	15	30	N	<20	10	50	N	5	N	300	20	N	150	N
154	QUI2762S	N	5	10	15	150	N	<20	7	30	N	5	N	100	30	N	30	N
155	QUI2764S	N	7	50	20	30	N	N	15	30	N	7	N	<100	50	N	30	N
156	QUI2766S	N	5	20	15	30	N	<20	15	30	N	5	N	<100	30	N	30	N
157	QUI2767S	N	7	70	10	30	N	<20	10	30	N	5	N	<100	50	N	20	N
158	QUI3201S	N	N	<10	15	50	N	N	10	20	N	5	N	N	30	N	50	N
159	QUI3203S	N	7	20	20	30	N	<20	30	20	N	7	N	N	50	N	50	N
160	QUI4243S	N	5	<10	7	70	N	N	5	30	N	5	N	300	20	N	50	N
161	QUI4245S	N	5	<10	7	300	N	<20	<5	30	N	<5	N	150	15	N	70	N
162	S0038S	N	7	50	30	50	N	N	30	30	N	7	N	200	50	N	50	N
163	S0040S	N	7	50	15	30	N	N	20	30	N	5	N	300	50	N	<10	N
164	S0045S	N	7	50	20	30	N	N	10	50	N	7	N	100	70	N	30	N
165	S0047S	N	7	30	30	50	7	N	15	30	N	7	N	500	100	N	50	N
166	STC2769S	N	7	70	30	70	N	<20	50	20	N	7	N	<100	50	N	100	N
167	STC2771S	N	7	50	15	30	N	<20	20	20	N	7	N	N	50	N	20	N
168	STC2773S	N	7	100	15	30	N	<20	20	20	N	7	N	<100	50	N	30	N
169	STC3250S	N	7	20	20	30	N	<20	20	30	N	7	N	<100	50	N	30	N
170	STC3255S	N	7	15	20	30	N	<20	30	30	N	10	N	<100	50	N	50	N
171	STC3257S	N	7	20	15	30	N	<20	15	30	N	5	N	N	30	N	30	N
172	STC3258S	N	5	20	15	30	N	<20	10	30	N	<5	N	N	30	N	15	N
173	STC3296S	N	10	20	20	30	N	N	30	20	N	7	N	<100	30	N	30	N
174	STC3298S	N	<5	15	15	20	N	N	10	20	N	5	N	<100	30	N	50	N
175	STC3300S	N	<5	10	15	20	N	N	15	20	N	5	N	<100	30	N	50	N
176	STC3301S	N	10	50	15	30	N	N	20	20	N	7	N	<100	50	N	30	N
177	STC4223S	N	5	<10	15	30	N	N	20	20	N	5	N	N	20	N	50	N
178	STC4225S	N	5	<10	15	30	N	N	10	20	N	5	N	N	30	N	50	N
179	STC4227S	N	5	20	15	20	N	N	7	20	N	5	N	N	30	N	30	N
180	STC4229S	N	7	20	7	20	N	N	15	20	N	5	N	N	30	N	15	N
181	STC4275S	N	5	10	10	20	N	N	7	20	N	<5	N	N	20	N	15	N

BLE 3. STREAM-SEDIMENT SAMPLE LOCALITY AND ANALYSES IN THE BUTTE 1°X2° CUSMAP QUADRANGLE,MONTANA (cont)

MAP #	SAMPLE	S-ZR	S-TH	AA-CU	AA-PB	AA-ZN	AA-AG	AA-CD	AA-BI	AA-SB
153	QU12760S	300	N	7.00	7.0	5.0	.65	.54	N	1.0
154	QU12762S	300	N	3.00	4.0	5.0	.11	.31	N	N
155	QU12764S	300	N	13.00	15.0	43.0	.12	.78	N	1.0
156	QU12766S	300	N	9.00	7.0	6.0	.34	.32	N	N
157	QU12767S	300	N	2.00	6.0	5.0	.07	.17	N	N
158	QU13201S	200	N	19.00	9.0	14.0	.26	.30	7.0	N
159	QU13203S	200	N	14.00	6.0	14.0	.11	.20	1.0	N
160	QU14243S	200	N	5.00	9.0	12.0	.07	.08	N	N
161	QU14245S	300	N	4.00	10.0	17.0	.17	.27	N	N
162	S0038S	150	N	19.00	18.0	33.0	2.40	.40	2.0	7.0
163	S0040S	150	N	6.00	8.0	36.0	<.05	.25	3.0	2.0
164	S0045S	150	N	15.00	12.0	12.0	<.05	.30	1.0	2.0
165	S0047S	150	N	19.00	11.0	16.0	.05	.35	2.0	2.0
166	STC2769S	200	N	22.00	8.0	7.0	.31	.36	N	1.0
167	STC2771S	300	N	5.00	4.0	4.0	.07	.17	N	N
168	STC2773S	300	N	5.00	3.0	3.0	.06	.17	N	1.0
169	STC3250S	300	N	19.00	10.0	7.0	.17	.57	1.0	1.0
170	STC3255S	300	N	14.00	13.0	8.0	.36	.68	1.0	N
171	STC3257S	300	N	7.00	6.0	5.0	.14	.57	1.0	N
172	STC3258S	300	N	8.00	11.0	29.0	<.05	.90	1.0	N
173	STC3296S	150	N	25.00	12.0	28.0	.18	.46	N	1.0
174	STC3298S	50	N	24.00	14.0	22.0	.18	.40	N	2.0
175	STC3300S	100	N	38.00	18.0	34.0	.36	.80	N	2.0
176	STC3301S	200	N	13.00	8.0	20.0	.06	.25	N	4.0
177	STC4223S	150	N	24.00	16.0	4.0	.36	N	N	N
178	STC4225S	100	N	20.00	12.0	22.0	.20	N	N	2.0
179	STC4227S	100	N	21.00	15.0	15.0	.61	.35	1.0	1.0
180	STC4229S	300	N	7.00	7.0	4.0	.32	.20	1.0	1.0
181	STC4275S	300	N	7.00	7.0	4.0	.13	.07	N	N

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